December 1971

Smithsonian

A sea-level canal problem
for an Atlantic angelfish (p.12)
Can it survive in Pacific?

BLENDED SCOTCH WHISKY • 86.8 PROOF • THE FLEISCHMANN DISTILLING CORPORATION, N.Y.C. SOLE DISTRIBUTOR

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Outfox the Fellow in the Bright Nightgown

A CHARTER SUBSCRIPTION OFFERING

He was a two-quart-a-day man (double martinis on waking, if you will). Yet he detested messy drunks, and never missed a performance because of liquor.

He was an insomniac of such proportions that sometimes he could only achieve sleep under a beach umbrella on which a garden hose sprinkled imitation rain. Yet he referred to death (mysteriously, but without real aversion) as "the fellow in the bright nightgown."

He was unforgettably, incomparably, uniquely W. C. Fields, and his lesson was that style, style, style is all. Rhetorical style. Theatrical style. Psychological style. *Style, the surest outward sign of substance, of a special and original inward view.*

And so, it is to this sure, true, blithe spirit, "Uncle Willie," that we dedicate a new magazine. Our name: AUDIENCE. Our purpose: to outfox the fellow in the bright nightgown by keeping you alive to beauty, to humor, *to today.*

THE PEOPLE

AUDIENCE celebrates excellence wherever excellence is to be found — brownstone, commune, playing field, concert hall, garret, campus, proscenium, foundry, ghetto, chateau, Volkswagen bus.

Our Editorial Board is something else again:

Alan Arkin, Saul Bass, Saul Bellow, Robert Bolt, John Cassavetes, Marisol, Inge Morath, Gordon Parks, Anne Sexton, Robert Penn Warren, Tom Wicker, John A. Williams.

THE GRAPHICS

AUDIENCE is published every other month — a magazine for enjoying at leisure. It comes to you in hard covers, without advertising — a magazine for saving. It is designed by Seymour Chwast and Milton Glaser, whose Push Pin Studios recently became the first American design group ever honored with an exhibition at the Louvre. Their pilot issue of AUDIENCE, by the way, has already won top honors from the prestigious Society of Publication Designers — an unheard-of coup first time out.

Specifications? Probably not even a Medici Pope could have commanded a book more opulent, more lavish. 216 square inches to the open spread. And depending on the contents of individual issues, a positively sensuous interlacing of papers. Papers for art reproduction, of a weight and quality for framing, and color plates by the bin. Rich tint papers for text. Typefaces of custom design. Foldouts. Stitchins. Endpapers. And for permanence, heavy board covers. In graphics, too, AUDIENCE is a celebration of style. A celebration of excellence.

THE DEAL

Where available in a very few expensive metropolitan bookstores, AUDIENCE will carry a cover price of $4.95 the issue, or $29.70 for the full volume year. *A reward for becoming a Charter Subscriber, however, is saving almost half this cost—provided you're prompt in using our coupon:*

Volume I, Number One is, as you can imagine, in short supply. As much as we'd like to accept all comers, inevitably we will have to disappoint the stragglers.

"Don't let 'em bamboozle you, son,"

Fields once said, "but never drink anything stronger than gin before breakfast, either." Our magazine is guaranteed to please. But if, for some reason, AUDIENCE *should* leave you feeling bamboozled, return it, and so much for AUDIENCE and you.

CONTENTS OF THE VOLUME ONE, NUMBER ONE ISSUE

"It was Fields who taught us that a man's ideas are not, ultimately, as important as his imaginative stake in reality, and that Earl Long, in his pajamas, with his stripper, is indescribably preferable to Billie Sol Estes, with his Sunday-piety and sex-segregated swimming pool."

John Clellon Holmes has written the dedication of our premier issue to W. C. Fields with "Uncle Willy and Us" Drawings, Edward Sorel.

"Nijinsky had a pair of feet you'd have had to see to believe. His heels and the base of his toes were equidistant from his ankles. No other mammal with feet like that had ever been seen outside Australia."

Nelson Algren writes on a standing skirmish between the dancer and his impresario, Diaghilev, by way of proving an Algren theory that integrity in art is "a matter of who swings the mackerel." Illustration, Milton Glaser.

"Q. If you could change one character trait in yourself, it would be?
A. My shyness."

Answer on a Playmate Data Sheet, required of each candidate before her photograph, posed nude, is considered for a Playboy foldout. The hilarious piece is by Tom Meehan, and it's called "We Like to Find a Late-Maturing Girl." Illustrations, Robert Grossman.

"In a village somewhere in the Ukraine there lived a poor man called Todie. Todie had a wife, Shaindel, and seven children, but he could never earn enough to feed them properly. He tried many trades and failed in all of them. It was said of Todie that if he decided to deal in candles the sun would never set . . ."

Blend Sholem Aleichem with Hans Christian Andersen, and you get Isaac Bashevis Singer's "Shrewd Todie and Lyzer the Miser," one of two fables clearly marked for posterity in the issue. Illustrations, Seymour Chwast.

THE COUPON

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Smithsonian

Volume 2, Number 9

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Some down-to-earth reasons for buying an Olds Ninety-Eight:

1 Many of the "extras" you want are standard on Ninety-Eight. Automatic transmission, for example. Power steering. And power front disc brakes. On Ninety-Eight Luxury models, a two-way power front seat is standard. And power side windows.

2 The Ninety-Eight is a big car. And that's a very practical consideration if you happen to have a big family. Or if you like to take driving vacations. Or weekend trips to the lake. The Ninety-Eight seats six—not elbow to elbow—but comfortably, with room to stretch out. And you can pack your golf clubs, outboard motor, beach gear and luggage into the generous 20.8-cubic-foot trunk.

3 Ninety-Eight is a superb road car. Olds' exclusive ride system incorporates a combination of engineering advances in chassis, suspension and steering. You negotiate scrubboard roads, chuckholes, hairpin curves and smooth interstate highways with ease.

4 Ninety-Eight's front bumper is exactly what the name implies. A bumper. It's built of heavy-gauge plated steel – and mounted on new spring-steel supports that flex to help absorb minor impacts, then return to position.

5 The Ninety-Eight engine is a 455-cubic-inch Rocket V-8. While it's so soft-spoken you hardly know it's there, you have all the reserve you could ever want. And it runs just fine on no-lead, low-lead or regular gas.

6 Surely security is an important reason for considering an Olds Ninety-Eight. The very fact that it's big – over 4,500 pounds – makes you feel secure. But there's more. In the doors beside you are tough side-guard beams. Over you is a reinforced double-steel roof. In front of you is an energy-absorbing steering column. And all around you are other GM safety features.

7 Ninety-Eight is loaded with little niceties that make traveling by auto more than just transportation. Extremely efficient soundproofing helps keep outside noises out. The front seats are six inches of solid foam—not a thin layer of padding on ordinary springs. Fine fabrics and plush carpeting surround you. The outside mirror is remote-controlled. Luxury models have front and rear cigarette lighters, an armrest in the center of the rear seat, even a clock exclusively for the convenience of rear-seat sedan passengers.

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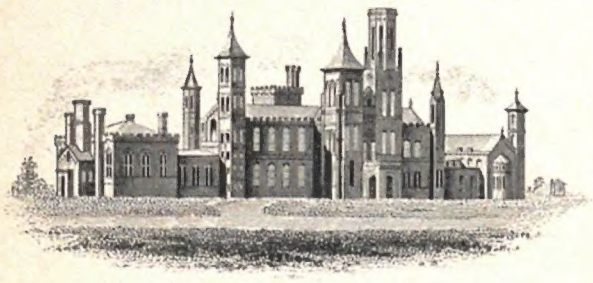
Secretary Ripley's comments

The view from the castle



On our 125th anniversary: congratulations from many, challenges from a few and measured optimism about the future

The Institution's 125th anniversary on September 26 brought us more than a hundred varied and colorful greetings from around the world. Foremost among them, of course, were those from President Nixon and the Congress of the United States. Mr. Nixon, proclaiming the 26th as a special day to honor the Smithsonian, wrote of the Institution's public service and of our global task of "enlarging Man's knowledge of the past, his understanding of the present and his preparation for the future."

Another particular pleasure was a letter from former President Truman, who had proclaimed our 100th anniversary in 1946. Mindful of the passage of a generation since then, he spoke of the importance of our work—"increasingly recognized in recent years"—and repeated his congratulations of 25 years ago.

Welcome words came from Oxford University and from the Royal Society of London, both looking back to James Smithson's time. Oxford reminded us that Smithson entered Pembroke College, Oxford, in 1782 at the age of 17 and took his M.A. four years later, while the Royal Society—of which Smithson was a member—reminded us that our two institutions share a common purpose.

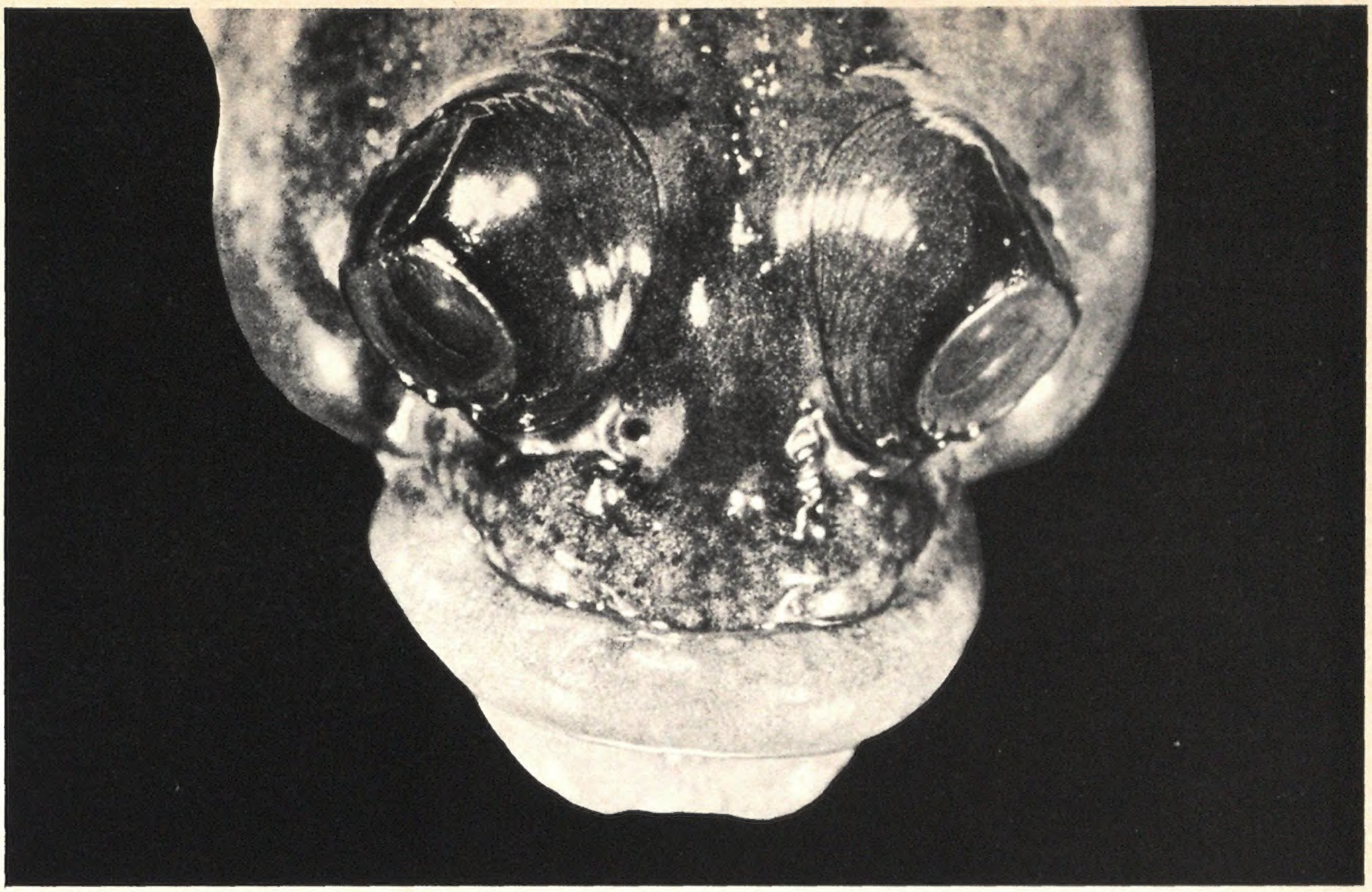
Greetings came from our colleagues everywhere—from the National Academy of Sciences, from the AFL-CIO and from Princeton University whose president, Robert F. Goheen, described the many ways in which that great university reveres and commemorates our first Secretary, Joseph Henry, who would almost certainly have been the president of Princeton if he had not set his heart on the Smithsonian instead. He did serve for a number of years on the university's Board of Trustees.

Particularly pleasant was the message from Charles Cunningham, sagacious director of the Art Institute of Chicago and chairman of the U.S. Committee of the International Council of Museums, who wrote: "We of the staff of a great museum of art are grateful that the Smithsonian exists in its myriad and multifold activities as an agency of the government and, in a real way, the conscience of knowledge for our nation."

But if the Institution can in any meaningful sense represent the government's conscience in culture, art and science, how are we to react on the one hand to the traditional National Congress of American Indians, which commends us for our preservation of Indian values, especially in the recent Folklife Festivals on the Mall as well as in our forthcoming Indian Handbook (to be completed in 1976)—and on the other hand to Deganawidah-Quetzalcoatl University in Davis, California, whose executive director wrote that they could not congratulate the Smithsonian on its academic, pompous (and presumably racist) past, but looked forward to the future?

We too are hopeful for the future, as the greetings continue to pour in from Australia, Ethiopia, Ghana and the Ivory Coast. Our friends are legion and so are our hopes for the next generation, tempered though they may be by a realization of the stresses and traumas which surround us on every hand. Man continues to be subject to frailty, but we remain optimistic—and long may the Smithsonian's blue-and-gold flag wave from our bold and jaunty turrets!

S. Dillon Ripley



*a new discovery...vision through goggly eyes

Not all fishes live only in the water. Walking catfish, mudskippers, flying fish and many other species hunt on land or in the open air. Normal fishes are myopic out of water, but the amphibious ones — like the bulging-eyed creature above — have special eyes allowing them to see through the air. In his fascinating article in FAUNA, Dr. Jeffrey Graham of the Smithsonian Tropical Research Institute shares his discoveries of how amphibious fishes can see. And his vivid illustrations, including close-up photos, are superb. But fish vision is just one of the exciting new discoveries reported in FAUNA. There are many more in every bimonthly issue.

FAUNA itself is new — a new magazine and a new concept: it is both a scientific journal and a popular magazine. It brings you the latest discoveries reported by the very research people who make them. FAUNA's authors and editors are exclusively professional zoologists. They relate new information about familiar animals... they introduce you to animals you never even heard of before. All articles in FAUNA are written in depth, but in non-technical terms. Readable, stimulating, but not superficial, they reveal a thorough picture covering all aspects of wild animal life — behavior, ecology, physiology, habits, distribution and evolution. And illustrations, many in full color, are the finest imaginable.

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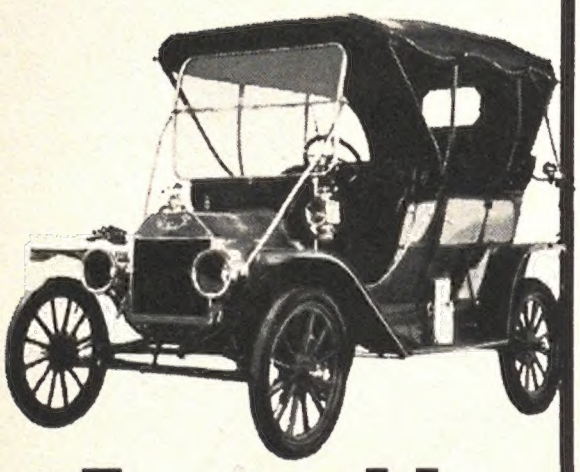

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Letters to the Editor

Pleasure-seeking brains

Dear Sir: In regard to your article in the October issue, "Pleasure-seeking brains . . . ," it always makes me nervous to see evidences of the mania men have for devaluing feeling in favor of thinking.

Maybe vandalism is apelike, but so is maternal love and love of peace. The apes have a social mechanism for avoiding violence as a response to aggression that we might well emulate. The human architects of war and other atrocities are all too capable of rationalizing their idiocies. Why should we want to divorce ourselves from the animals?

Is Man's ego still so weak that he cannot accept the relationship? At least the apes don't rend each other's flesh for the sake of an idea.

Ann Nydele
New York City

Dear Sir: H. J. Campbell, in his article on "Pleasure-seeking brains," seems to be saying that in order to survive in our society we must become a thinking people, and only those who acquire the higher skill of thinking will be able to survive.

I think he is underrating feeling. I have been activating my own limbic pleasure regions of my brain by helping others to learn how to learn and how to think more efficiently. This has been accomplished through Optometric Vision Training. And the one way that is most effective in stimulating the process of learning, particularly for a child with a learning problem or a low achiever, is by using his motor systems to help him to develop his sense of feel. The greater the degree of difficulty he has in achieving, the poorer he is at feeling. By using his own body to establish his experiences of feeling, he appears to learn how to make relationships, and making relationships is considered to be thinking. When he is able to think more efficiently, his vision also becomes more efficient, and he is able to process visual information.

Expanding from this base, he becomes both a feeling and thinking individual, and he experiences successes which he never found himself capable of before.

Dr. Albert L. Shankman
Norwalk, Connecticut

Dear Sir: In his discussion of the discovery of the presence of pleasure areas in the brain, Dr. Campbell mentioned experiments with mental patients. Perhaps similar experiments might be valuable in rehabilitating drug addicts.

June Cook
Lowell, Arkansas

Cabin in the woods

Dear Sir: I am building a log cabin, and I appreciate Mr. Seib's sentiments about the trials and ecstasies of building a dwelling with your own hands.

I was greatly struck, however, by his comment: " 'NOTICE—Nothing to Eat or Drink and No Valuables Inside. Please do not Break in. C.B. Seib, Owner.' It seems to have worked."

You see, I too have been planning to put a sign on my door. But I had in mind something closer to the following: "NOTICE—There is plenty to eat inside. Please warm yourself by the fire. There is a fresh spring to your right and down the hill. My home is yours."

Scott Landis
Blue Hill, Maine

Dear Sir: I know how Charles B. Seib feels about his cabin in the woods, because my husband recently built one in the mountains.

Ours is one large room—16-by-20 feet, with a roof pitched so high that the house is as tall as it is wide, with glass set in both ends of the eaves for more light.

When I try to describe the utter peace and beauty we have found, invariably someone will say in great horror, "no bathroom!" They don't hear me when I mention that the stream, gushing and leaping over its stones, sings us to sleep at night, or that the whippoorwills, just at

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Music authority Frederic V. Grunfeld has written the companion book. It includes full-color reproductions of paintings by Rubens, Velázquez, Caravaggio, Vermeer, Hogarth . . . rare photographs of art objects, Baroque churches and palaces . . . specially commissioned diagrams and charts . . . an incomparable four-page section on the musical instruments of the age.

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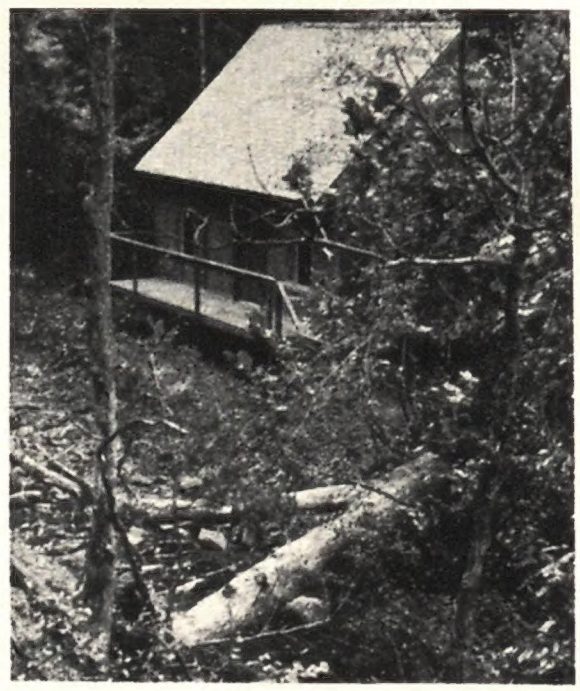
Mrs. Frank Kramer
Glen Burnie, Maryland



The Kramers' cabin

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Salmon

Dear Sir: The article, "Salmon spectacle: autumn run of spawning sockeye" by Betty W. Carter, states that construction debris caused the blocking of Hell's Gate canyon, making it impassable to spawning salmon in 1913. Then, the author says that it was not until 1945 that fishways were installed to help the salmon pass the impediments. If salmon always return to their place of birth to spawn, how did they reach the Fraser River watershed, above Hell's Gate, during those 32 years?

A. C. Joslin
El Campo, Texas

The Hell's Gate obstruction was completely impassable for the first spawn-runs of 1913, and only late in the season was it partially cleared. More clearing was done in the next few years, but it was still a major block until 1945. As the article

states, "It has taken more than a quarter of a century of research and scientific regulation plus the installation of the Hell's Gate fishways for the Fraser sockeye to build back to merely a third of their number before man's carelessness intervened." Ed.

Trash or treasure

Dear Sir: Regarding Patrick Ryan's "Who steals my purse steals trash—so why guard it?"—I'll tell you why. Because it's *my* trash, that's why. And while my trash is my treasure, and vice versa, I do not wish it to change hands except at my option.

My worthless purse was snatched right off my arm one bright Monday morning half a block from my office.

Later, thieves broke into my car and took an anonymous dun-colored bag containing a $69 tent without the necessary poles. The have-nots responsible for that caper had no way of knowing what was in the bag before they filched it and were probably no wiser afterward.

Most of my worldly treasures are portable enough, but precious few of them would bring much at a hock shop.

But they *are* precious to me. Replacement would be a long and slow process, because I have always been a financial near failure.

Nancy C. Jack
Kansas City, Kansas
Does Patrick Ryan have an alibi for the hours the thefts occurred? Ed.

Salem Church Dam

Dear Sir: Thank you for the excellent September issue coverage of the Salem Church Dam controversy. It certainly needs continuing attention. Only recently, for example, Virginia's Governor Linwood Holton endorsed, without public hearings, a new Salem Church plan which would involve the shipment of large volumes of water to northern Virginia. Key state environmental officials, and perhaps even the Chief of Army Engineers, were caught unawares.

In part because of the constantly shifting, surely-there-must-be-some-way-to-justify-it atmosphere surrounding Salem Church, and largely because the project would destroy two of the East's finest rivers in the name of recreation values which no one seems to want, the Conservation Council of Virginia has estab-

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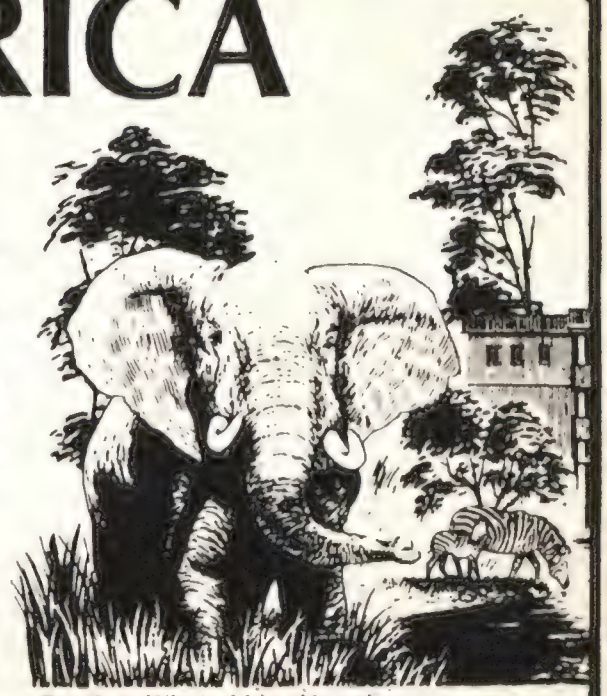

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William T. Reed, III, President
Conservation Council of Virginia, Inc.
Richmond, Virginia

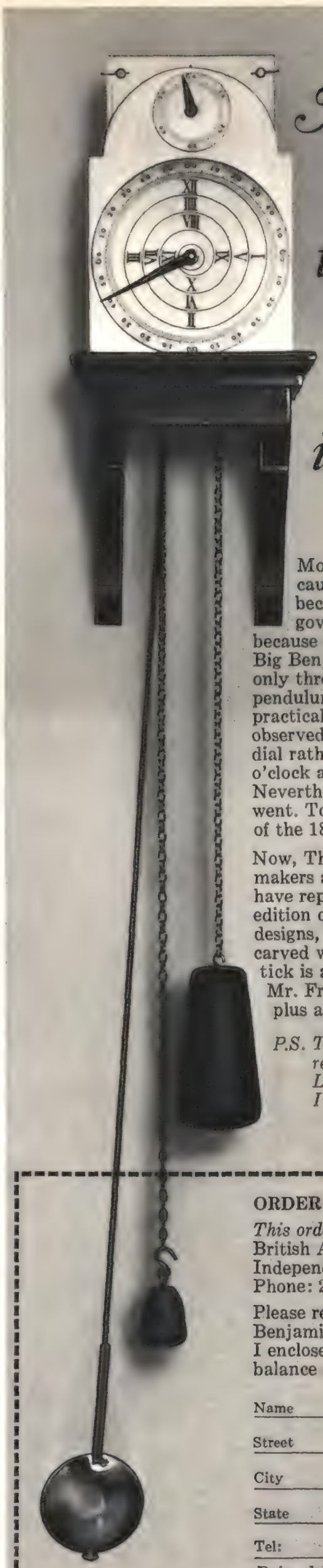
The Continent in Our Hands

Dear Sir: A writer who replies to critics is generally poorly advised, but I feel I must correct misrepresentations in Hal Borland's review of my book, *The Continent in Our Hands.* Mr. Borland asserts that some parts of the book "are as dull as the author finds the desert." There are few sentences about particular stretches of desert I found dull. There are pages upon pages that testify to the fascination the desert had for me.

"When he bemoans the absence of farmers," Mr. Borland writes, "he is racing past the wheat fields of South Dakota. One wonders if he expected the wheat farmers to be standing in their fields, in early May, waving to the tourists." My explicit point in the passage referred to was that the tillers of those fields are in fact agro-businessmen and that the farmer as he has been traditionally is vanishing.

"I am surprised," says Borland, "that he fails to point out that even our biggest cities are lost in the landscape, once one gets out of range of their suburbs." Ninety-five percent of the descriptive parts of the book are about the landscape beyond the cities, on which the cities have not impinged.

"The problem," he writes, "and I wish he had stated it more clearly, is to keep the cancerous blight from engulfing those inland areas." In setting forth the point of the book, I say that "our continent is steadily deteriorating. The most powerful forces among and within us are bent on debauching it for the greater opulence of a swarming, hedonistic population and the proliferation of an awesome and inhuman ugliness" and urge that "the highest beliefs we profess plead the continent's cause."
Charlton Ogburn
Oakton, Virginia
Hal Borland's reply: "It saddens me to think Mr. Ogburn missed the favorable passages in my review as completely as he evidently thinks I missed the key points in his book. All I had to go on were his own words, and as a reviewer I must call them as I see them." Ed.



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P.S. Thwaites and Reed have two other important responsibilities (1) To keep Big Ben on time in London (2) To keep watch on the Smithsonian Institution Clock which they also built.

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By Meredith L. Jones and Raymond B. Manning

A two-ocean bouillabaisse can result if and when sea-level canal is dug

How two different environments may mix is the subject of intensive study in Panama by Smithsonian staff and others

Photographs by William K. Sacco

In 1914 Americans felt the warm glow of accomplishment as the first ship traversed the newly opened Panama Canal. With its six double locks this wonder of the world raised the vessel 85 feet to freshwater Gatún Lake, then lowered it again to sea level. It shortened to a little more than 50 miles a voyage that would have encompassed some 7,800 miles—and the furies of Cape Horn. The canal constituted a splendid task, well done by a young and vigorous nation.

Now, 57 years later, the Panama Canal is out of date. Its 12 locks are each 1,000 feet long, 110 feet wide and have a minimum depth of 40 feet. Until World War II, American vessels were built within those specifications. But such limitations are now unrealistic. Now supertankers are being built that are hundreds of thousands of tons, over 1,132 feet long, with 175-foot beam and an 81-foot draft. Though they are designed to avoid the expensive tolls of the Panama Canal and push around Cape Horn in comparatively solid comfort, their enormous dimensions indicate what is happening in merchant vessel design. Today, more than 1,400 ships are unable to squeeze through the Panama Canal locks.

For this and strategic reasons, a second canal across the Isthmus, built at sea level to avoid the cost of locks, has been under study for many years. Thirty different potential routes were examined in 1947, and in 1964 legislation was passed establishing the Atlantic-Pacific Interoceanic Canal Study Commission. This group selected four routes, one of which involved converting the present canal.

The routes being considered (map p. 15) include one running parallel (8) to the existing canal (7) and across the Colombian border (10). There are two other possible routes. Excavation would be by conventional or possibly the controversial nuclear method.

These two almost identical sergeant majors are geminates—from separate populations on each side of the Isthmus of Panama. The Pacific's *Abudefduf troscheli* (left) and the Caribbean's *Abudefduf saxatilis* shared the same habitat eons before the land barrier rose between them.

The 65-foot research vessel *Tethys* lies at anchor in the San Blas Islands of the Caribbean.

Obviously construction would have some profound effects on the land ecology of the Isthmus. That is a story in itself. What concerns us here is the effect that a sea-level canal would have on the marine environments of the Pacific and Caribbean waters adjacent to it, if and when the life forms of both areas began to mingle together.

For about 90 million years the Pacific and Caribbean were continuous, sharing a common shallow-water fauna. Geological evidence indicates that during the Cretaceous period, between 135 and 65 million years ago, at least four different, major connections linked the Atlantic and Pacific, and during the Tertiary period the area between northern South America and Nicaragua lay under water. It hosted a large and diverse marine fauna at that time.

For the last one-to-five million years the Isthmus has separated the seas and, until the 20th century, barred the distribution of marine life. Fauna of the eastern Pacific has not changed much since Miocene-Pliocene times, but, in the Caribbean, cooling of the water by a long and severe glaciation decimated life forms. Separated, the two marine areas have differentiated, but the fauna still shares many common or similar elements. The distinguished American ichthyologist, David Starr Jordan, noted the resemblance between the fish of the two areas and introduced the term "geminate species" to describe pairs which had differentiated from a common ancestor. The two American sergeant majors, *Abudefduf saxatilis* and *Abudefduf troscheli* (see pages 12-13) are both common in shallow water, *saxatilis* in the Caribbean and *troscheli* in the eastern Pacific. About 45 percent of the crabs of the two areas are considered geminates. A common shore crab, the Sally Lightfoot, *Grapsus grapsus,* is found on both sides of the Isthmus, but the ghost crab, *Ocypode,* is represented by different species on each coast. Of the more than 3,500 species of marine mollusks on both coasts, 440, or 12 percent, are considered geminate species.

The present Panama Canal, with its locks and freshwater lake, has largely maintained the isthmian barrier, and there has been little mixing of life forms since it opened. Moreover, the presence of a Caribbean species in the Bay of Panama within the Gulf of Panama on the Pacific side, might not mean that it had successfully traversed the canal. It simply might never have been detected before because of limited sampling of specimens.

The proposed sea-level canal, however, would allow a free interchange of organisms between the Caribbean and the Pacific for the first time in perhaps five million years. We cannot be sure what the effect would be. We simply do not yet know enough about the marine floras and faunas. We lack detailed knowledge of the mere presence of the multitude of invertebrate animals, let alone the intricacies of their relationships, food chains and behavior patterns.

Dr. Jones is a curator in the Institution's Department of Invertebrate Zoology. Dr. Manning, co-author of an article on tidal areas (see July SMITHSONIAN*), is now researching crustaceans.*

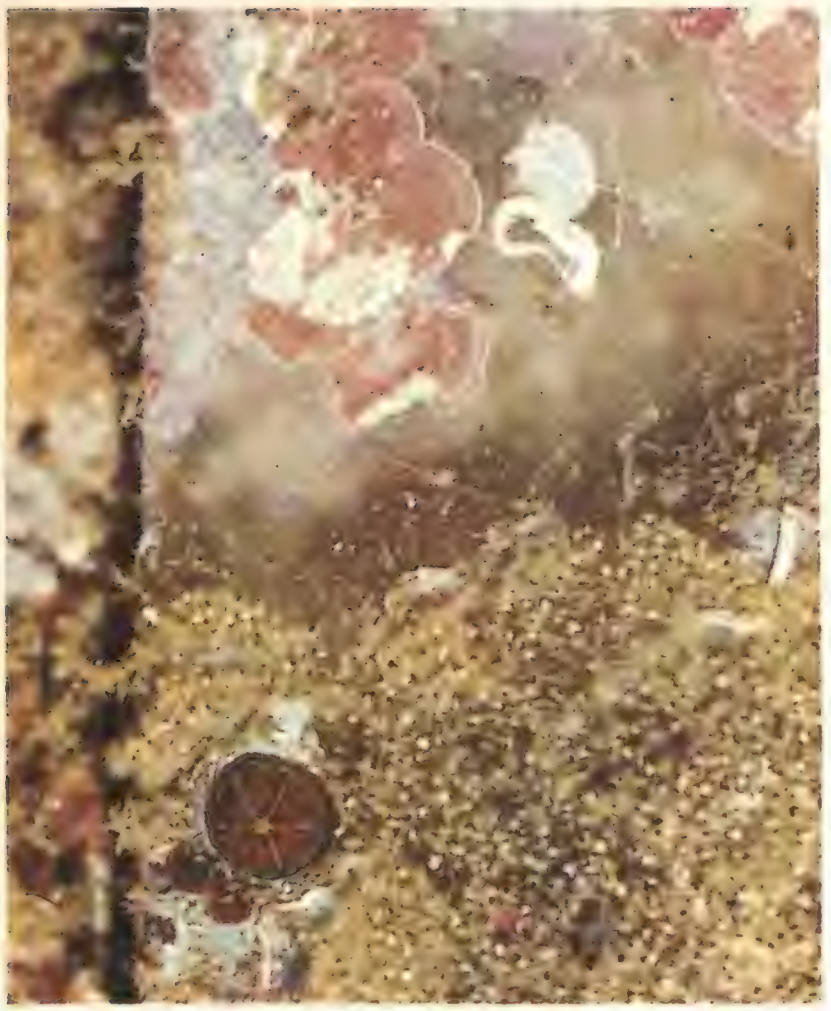
Shaded afterdeck *(above)* provides room for diving and investigating collections of specimens.

As might be expected, opinions about the proposed canal's ecological effects vary widely. Dr. John C. Briggs, a professor of zoology at the University of South Florida, called the new canal a "potential biological catastrophe." He suggested that the competition by invading animals in the tropical eastern Pacific would cause eventual widespread extinction of native species, but that the tropical Atlantic fauna would suffer less because Caribbean ecosystems are more stable. Dr. Ira Rubinoff, assistant director for marine biology at the Smithsonian Tropical Research Institute called it "an opportunity for the greatest biological experiment in Man's history."

One point of agreement among scientists is that we must learn a great deal more about the organisms and environments in the area. Many scientists have pointed out the need for large-scale biological surveys prior to the opening of a sea-level canal so that there would be some basis for assessing subsequent changes.

The Smithsonian Institution is in a unique position to help provide some of this basic information. Since 1946 the Institution has operated a research station on Barro Colorado Island in Gatún Lake. Its expanded research facilities in Panama are called the Smithsonian Tropical Research Institute (STRI). Included in this complex are a marine laboratory on Naos Island,

Isthmus of Panama bars the Atlantic (1) from Pacific (2). Ships passing from former to latter go from west to east, to the confusion of young geographers. One proposed sea-level canal route (8) parallels the old canal (7); another bypasses existing locks (9). A third follows Panama-Colombia border (10). The Smithsonian Tropical Research Center occupies Galeta Island (3), Punta de San Blas (4) and Barro Colorado Island (6) in freshwater Lake Gatún. Many studies are carried on out on Las Perlas Archipelago (5) off the Pacific coast.



Calcareous algae and a juvenile coral begin growing on a plastic settling plate, which serves to isolate areas for close study.

Smithsonian laboratory is on Galeta's reef. An extremely low tide reduced the wash of waves. Result: severe desiccation and a dead octopus.

at the Pacific terminus of the present canal, and a smaller marine station on Galeta Island, on the Caribbean coast.

The permanent staff includes four marine scientists whose long-term investigations are complemented by the research of outstanding predoctoral and postdoctoral students as well as studies on a variety of topics by a large number of visiting scientists. Staff members of the Smithsonian's National Museum of Natural History also participate in studies on basic marine biology. In addition, the University of Panama supports a small but active research program, primarily in the Bay of Panama, and is planning a research station on the Pacific coast near Punta Paitilla which lies within Panama City.

Much of the Smithsonian's marine research deals with specific communities of organisms. Caribbean coral reefs are easily accessible to scientists at Galeta Island, and already researchers are analyzing the structure, diversity and feeding habits of the corals of both coasts and have carried out an extensive survey of marine algae.

Some 130 different kinds of worms

The Environmental Protection Agency is sponsoring an interesting comparative study involving a group of STRI workers headed by Dr. Charles Birkeland. They make regular collections and observations along transects through the turtle grass and coral adjacent to Galeta and on the extensive rock platform on Punta Paitilla. The numbers of different organisms collected are staggering—for example, of more than 130 species of small worms found, most were unidentifiable. The results of these studies will provide a yardstick for measuring the effect of oil spills, which are not infrequent in this area.

Dr. Peter W. Glynn is concerned with annual changes in species density and composition of a community of animals inhabiting sandy beaches near the Naos laboratory on the Pacific coast. Roberta W. Rubinoff is observing the ecology of populations of tide-pool fish in the same places. Mrs. Rubinoff has studied the isolating mechanisms of fish—those factors that help maintain the identity of different kinds of fish. This work will have a direct bearing on future studies if the faunas of the two coasts are mixed together.

Marine scientists of the University of Panama are scrutinizing filter-feeding invertebrates as well as shrimp and offshore plankton. For the past several years, a UNESCO team has made general bottom collections mostly from eastern Pacific fishery grounds in the Gulf of Panama. University of Miami personnel have made bottom and midwater collections on both sides of the Isthmus. The Puerto Rico Nuclear Center

made earlier collections in Panama and Colombia. Both the Miami and Puerto Rico studies are part of the pre-construction surveys for the new canal. The results are largely unpublished.

Presently, some of the staff and associates of the National Museum of Natural History are involved in building up representative collections from as many near-shore habitats as possible on both coasts of Panama. These could mark the beginning of an extensive biological census of the area.

Few species have successfully passed through the existing Panama Canal to become established on the other side. But two small Caribbean species have recently been detected colonizing the Miraflores Third Lock on the Pacific side. The third lock, an unused auxiliary, largely brackish, was constructed in 1941 and connected to the Pacific by a culvert. At high tides there is some slight exchange of water between it and the Bay of Panama. Dr. and Mrs. Rubinoff studied one of the fish, the small goby, *Lophogobius cyprinoides,* and concluded that the Caribbean and third lock populations of this fish were homogeneous. More recently, a population of a Caribbean blenny, *Lupinoblennius dispar,* was found by Dr. C. E. Dawson of the Gulf Coast Research Laboratory. There was no evidence that the blennies had established a breeding population in the Pacific. For most marine organisms, though, freshwater Gatún and Miraflores Lakes are an impenetrable barrier because most of them cannot regulate their body-salt content in fresh water. Several fish, such as the Atlantic tarpon and the snook, have successfully entered Gatún Lake but they have not become established in the Pacific.

Pacific temperature fluctuates widely

It appears that differences observed in faunas of the Caribbean and Pacific, adjacent to the present canal, may have developed in response to differences in the environments. Near the Atlantic canal entrance, for example, water temperature is relatively constant, with a seasonal fluctuation of about ten degrees. But on the Pacific side temperature may change more than 30 degrees F. in a year, and during the dry season upwelling in the Bay of Panama brought on by northerly winds may drop the temperature as much as 20 degrees in 24 hours. This, in part, helps to explain the absence of coral reefs near the shore in the Pacific, for reef corals require temperatures above 70 degrees.

In the Atlantic, the tidal range is usually less than two feet, but in the Gulf of Panama it may be 18 feet or more. In such an environment, intertidal animals must adapt to wide changes—an animal living near the upper end of the tidal zone may be left high and dry in intensive heat for long periods.

Oxygen bubbles from *Thalassia* grass in shallows off San Blas Islands. Sedimentation or cooler water from the Pacific side could disrupt process.

Flamingo-tongue cowries, *Siphoma gibbosum,* graze on the soft tissues of the sea fan, *Gorgonia,* in the shallow water of the Galeta Island reef.

Spotted or yellow-bellied sea snake, *Pelamis platurus,* may well migrate to the Atlantic side, but Atlantic fish may have to learn to avoid this poisonous species.

During the dry season, January to April, each coast may be subjected to different kinds of environmental changes. In the Atlantic, northerly (onshore) winds can bring high seas and strong surf which can physically disrupt shore habitats and increase sediments in suspension in the water. During such periods free-living animals such as snails and sea urchins can be dislodged. In the Pacific, northerly winds, pushing surface water away from shore, cause upwelling of bottom water near shore to replace surface water. This bottom water is much cooler and richer in nutrients, and brings on a blooming of microscopic plants which, in turn, lure anchovies, predatory fish and sea birds.

In general, water in the Bay of Panama is less clear than in the Atlantic—tidal movements and river runoff may add considerable sediment to it. Sedimentation and high turbidity also affect corals adversely and probably have contributed, along with lower temperature, toward restricting inshore corals in the Bay of Panama. Conditions near some of the offshore islands are better suited to the development of coral patches and reefs.

There are striking differences in the coral communities of the Caribbean and the eastern Pacific, the latter area having fewer species and generally showing closer relationships with corals from other areas in the Pacific. Coral reefs in the Pacific waters of Panama are formed almost entirely of *Pocillopora* coral, although as many as 20 species of corals may occur there.

In the Caribbean, more than 40 species of reef-building corals have been found, including species of the genera *Porites, Acropora* and *Agaricia;* in general, the Caribbean corals are distinct from those known from other areas in the Indian and Pacific Oceans. *Porites* is one of several genera with species in both areas.

Both coasts have large areas of rocky shore in the intertidal zone. In the Pacific, barnacles and oysters are conspicuous in the upper tidal levels, and they offer many hiding places for smaller organisms. In the Atlantic, barnacles and oysters are much less abundant but, in the lower tidal areas, there are large numbers of attached algae—much less conspicuous in the Pacific.

Marine environments generally can be characterized as mild and constant, that is, relatively stable in the Atlantic, and rigorous and unstable in the Pacific.

Shallow-water habitats in the two areas are also

Though hard and limy, this Pacific coral skeleton has been deeply scarred by browsing parrot fish which would find a rich pasture in the Caribbean.

quite different. Lush coral reefs, extensive beds of sea grasses and a wide variety of attached algae characterize the Caribbean coast but are absent in the Pacific except for restricted patches and reefs of the coral, *Pocillopora,* on offshore islands. Carbonate sand beaches and mangrove swamps line most Caribbean coasts. The offshore reef platform may be exposed at low tide, and occasional combinations of low tide and high temperature will kill masses of marine organisms there. In the Pacific, numerous lava outcrops extend into the ocean, interspersed with beaches of mud and quartz sand and mangrove swamps.

There also are differences in the mangrove communities. In the Atlantic, prop roots of the mangrove, *Rhizophora,* support a large number of sponges, oysters, sea squirts and a variety of other animals, for the roots are exposed only for short periods. Pacific mangrove roots may be exposed for long periods between tides and their fauna and flora is reduced.

Conspicuously absent from the Bay of Panama are representatives of marine flowering plants or sea grasses. Turtle grass, *Thalassia testudinum,* forms dense beds from the lower intertidal zone to a depth of about 30 feet in the Caribbean. These beds support large populations of small shrimps, mollusks, a variety of animals which burrow in the bottom around the plants and a multitude of small organisms, including algae, which live attached to the leaves of the grasses.

Specifically, what might we look for when a sea-level canal cuts the Isthmus? In a 1970 report by the Committee on Ecological Research for the Interoceanic Canal, appointed by the National Research Council, possible major effects were suggested. These included the introduction of sea snakes and other troublesome forms into the Caribbean, the impact of parasites and pathogens—disease carriers—on resident life forms in both oceans, the destruction of marine communities by spoil and silt and the disruption of marine and freshwater communities before they can be studied.

As explained in a recent article in *Science,* the immediate impact of canals in the Great Lakes and the Mediterranean-Red Sea regions has not been a valid measure of the long-range environmental effects. In both areas there was definite lag between the opening of the canal and the onset of major biological changes. The Committee on Ecological Research pointed out

that we have learned from the Suez Canal that marine organisms do indeed migrate, that both active animals and fouling organisms are among the first to move through a canal, that populations change and that the changes may have an economic impact on commercial fishing, for example. In Panama we don't know whether the changes will be good, bad or indifferent.

Two marine organisms which live in the eastern Pacific but not in the Caribbean have received their share of attention since the possibility of a new canal was raised. The spotted or yellow-bellied sea snake, *Pelamis platurus,* is docile but highly poisonous. It lives in the open oceans and prefers clear offshore water, but is capable of tolerating fresh water.

Pelamis is the only sea snake in the Americas. Its migration through the sea-level canal is a definite possibility, and it has been suggested that it would be a "potential threat to the Atlantic community." Experimental work by Dr. Ira Rubinoff has shown that although predatory fish from the Pacific ignored the snake, Atlantic predators readily attacked it. Dr. Rubinoff concluded that if a sea-level canal were constructed, chances were good that the snake would colonize the Atlantic, but because of its interaction with new predators its spread would be slow.

The second animal that has been a source of concern is the crown-of-thorns starfish, *Acanthaster,* which occurs in some stable populations on certain of the offshore islands on the Pacific side of Panama. This starfish is an active predator on corals, and its recent population explosion in the central and western Pacific Ocean has resulted in widespread damage to coral reefs (see SMITHSONIAN, April 1970). At first it was believed that *Acanthaster* would destroy reefs, but recent evidence seems to indicate that the damage is not permanent.

The distribution of *Acanthaster* on the Pacific coast of the Americas is restricted, because of the general absence of coral reefs, but its possible effect on the luxuriant Caribbean reefs sends chills through some marine biologists.

Can an angelfish from the Atlantic survive in the Pacific (see cover)? We don't really know. We do not even know if it will move through a sea-level canal into the Pacific, and, even if it did, we know too little to predict how it would interact with animals already living there. Chances are good that this and other Caribbean reef organisms would not colonize the Pacific unless the environment became more like the Caribbean. We know too little to predict how it and other organisms in the Caribbean coral reef habitat will interact with invaders and whether it will encounter diseases or parasites for which it has no defenses.

Take all of these areas of ignorance, and many more, and multiply them by the number of plant and animal species on Panama's two coasts and their adjacent waters, and you begin to get some idea of the *terra incognita* scientists are approaching.

This much we know: There will be changes when and if the waters meet. It is imperative that we measure and assess them as best we can before the final decision is made.

Eastern Pacific coral tends to be sparser and less colorful than in the Caribbean, though sometimes it builds great reefs. Starfish lies in it.

Rich, variform coral reefs fringe most of the Atlantic coast of Panama. This crinoid, or feather star, is one of many animals that live there.

Photographs by Yoichi Okamoto and Hans Trebor

A new dazzle for performing arts in the Capital

The operation of the John F. Kennedy Center gives Washington three long-awaited facilities for music, drama and the dance

One of the oldest clichés about Washington—still persisting in the national press—is that it is "culturally underprivileged" *(The New York Times)* or a "cultural wilderness" *(Newsweek)*. Whatever one's criteria, those are scarcely accurate descriptions of a place that has, for starters, more art museums than any other American city except New York itself; one of the country's leading resident theaters, the Arena Stage; and, in the Library of Congress, a longtime stronghold of distinguished chamber music.

The one element of truth in the charge is that Washington has not had, until recently, a suitable or even adequate place for large-scale opera or ballet. Thus the big international companies have either bypassed the Capital or, like Leningrad's Kirov Ballet, resigned themselves to performing on a makeshift stage in a hockey rink. This lack was partially remedied in July with the opening of the Filene Center at Wolf Trap Farm Park in suburban Virginia (SMITHSONIAN, September 1971). But that is a summertime operation.

The new era really began on September 8 when the John F. Kennedy Center for the Performing Arts finally opened its doors and gave Washington three auditoriums capable of accommodating any theatrical spectacle this side of an aquacade. They are shown in full operation on these pages.

It took 13 years, $70 million in public and private funds, the gifts of more than 30 foreign governments, the support of four Presidents and the indefatigable labors of its chairman, Roger L. Stevens, to bring the

At dusk the Center's white marble sheathing and bronzed columns are reflected in the Potomac.

Center into being. The process began in 1958 when President Eisenhower signed legislation creating a National Cultural Center. It was so known until 1964, when it was renamed the John F. Kennedy Center for the Performing Arts. Thus it became not only a national cultural center but the nation's official memorial to the late President. Technically, the Center is part of the Smithsonian, although it operates independently with its own board of trustees.

The building itself, clad in white Italian marble, was designed by Edward Durell Stone. It has come in for some harsh words from some architectural critics, who have compared it to a gigantic Kleenex box or a beached houseboat. But there has been little but approval for the three auditoriums under its roof.

The opera house was the first to open with Leonard Bernstein's specially commissioned *Mass,* described by him as "a theatre piece for singers, players and dancers." The concert hall was inaugurated the following night by the National Symphony Orchestra. And the Eisenhower Theater, the only one with an official name, had a slightly delayed opening on October 18 with Ibsen's *A Doll's House.* All three have been praised for superior acoustics and, except for some carping about the uppermost tier of the concert hall, for excellent sight lines.

Will it truly become a national cultural center? No one knows as yet. All that a building can really do for art is protect it from the weather; art is as likely to be found in an off-Broadway cellar as in a red-and-gold opera house. But hopes along the Potomac are high.

The 630-foot Grand Foyer has chandeliers from Sweden, mirrors from Belgium and a bust of JFK.

The 1,130-seat Eisenhower Theater is paneled in East Indian laurel. The curtain is a gift of Canada.

Opposite: The horseshoe opera house has a sunburst chandelier, given by Austria, and 2,334 seats.

Leonard Bernstein supervises the recording of his *Mass* on the stage of the concert hall.

The rectangular concert hall has notable acoustics and Norwegian chandeliers.

Backdrop for sightseers on the Entrance Plaza is a sculptured bronze wall, gift of Germany.

Members of the audience take an intermission stroll under the lofty exterior colonnade.

By Daniel Jack Chasan

A huge racetrack for protons at incredible speeds

At Batavia, Illinois, National Accelerator Laboratory physicists look for new and smaller particles and even higher-energy thrills

Except for the tall, wooden 19th-century midwestern farmhouses, the flat green fields could almost be the vast, fertile Indo-Gangetic Plain of East Pakistan. But this isn't Pakistan, it's Illinois, and you pass a cornfield on the left, then a small, fenced pasture that contains a knot of full-grown buffalo.

You turn right at another farmhouse and follow the road to a dusty construction area. There, beside two big white barns with arched roofs, you find a corrugated metal building, like the top half of a huge culvert, in which a team of high-energy physicists from the California Institute of Technology is setting up an experiment to verify the existence of something called an intermediate vector boson.

This improbable part of Illinois, with its unmistakable bison and hypothetical boson, lies within the 6,800 acres of the National Accelerator Laboratory (NAL), where hundreds of scientists, engineers and construction workers have just built the largest, most powerful particle accelerator in the world. The NAL machine will accelerate protons routinely to an energy of 200 billion electron volts (BeV), and at least for brief periods to 400 or 500 BeV. The world's second most powerful, at Serpukhov, USSR, produces only 76.

By way of comparison, the energy content of ordinary red light is slightly over 1½ electron-volts, and

Mr. Chasan, whose article on Seattle's Lake Washington appeared in July's SMITHSONIAN, *has also written for* The New Yorker *and* Esquire.

The Batavia accelerator's four-mile main ring is seen under construction amid Illinois cornfields. Construction is now complete and the ring covered.

An electrical plant rises from the cooling pond of the booster ring. Early stage is shown at bottom center on preceding page.

A herd of bison is maintained at Batavia, working as inexpensive grass cutters. Also, they lend an attractive "environmentalist" tone to the place.

that is sufficient energy to bring about many ordinary chemical reactions. But to create nuclear reactions and study the behavior of subatomic particles calls for vastly higher energy levels. The first cyclotron used for experiments, built in 1932 by Ernest O. Lawrence (the father of "big machine physics" in America), accelerated protons around a circle 11 inches in diameter to an energy level of 1.2 million electron volts.

Larger cyclotrons followed, and within a decade ten million electron volts of energy had been achieved. To a considerable extent, the size of an accelerator, or atom smasher as they used to be called, determines the energy level possible and, as physicists have hypothesized ever smaller and more evanescent particles to explain the behavior of nuclear reactions and the fine structure of matter, larger accelerators have been built to push into the incredibly high-energy realms where these interactions can be observed. The main ring at NAL is one-and-a-quarter miles in diameter; it probably is, as the public relations releases put it, "the world's largest basic scientific research instrument."

Protons and wildlife

The particles that can eventually reach 500 BeV are produced by ionization, stripping the electrons from hydrogen atoms leaving the positively charged nuclei. These protons are jacked up to 750,000 electron volts in a machine called the Cockcroft-Walton preaccelerator, a huge device that looks like a prop for a rather unsophisticated science-fiction movie. Then they are fired through a linear accelerator and whirled around a 500-foot-diameter booster ring before being shot into the four-mile main ring of the accelerator, where they race in rapid circles until they develop their full energy, traveling at 99.9 percent of the speed of light. A beam of protons can then be diverted out of the ring to be used in experiments at a variety of laboratories, including the unprepossessing "wonder building" where Cal Tech physicists have set up shop.

It may be hard to see exactly where the buffalo fit into all this, but they do. Deer were indigenous to the areas in which the Brookhaven National Laboratory and Lawrence Berkeley Laboratory were built, and a privately owned herd lived on the site of the Argonne National Laboratory, not far from NAL; once laboratory fences had closed those areas to hunters and suburban development, all three deer populations boomed. The site on which NAL now stands had no deer, either public or private, but the laboratory's directors had decided to let beef cattle graze there to keep the grass short. While they were scouting around for cattle, they discovered that buffalo were also available, and they couldn't resist getting buffalo, too.

Acquiring a herd of buffalo, leaving the trees and farmhouses standing and having the "village" of tacky one-story tract houses that hold the laboratory's temporary offices painted orange, blue and other bright colors are all part of NAL Director Robert R. Wilson's effort to build a laboratory that, in the words of Deputy Director Edwin Goldwasser, "will make you feel like you're in a laboratory, and not in a shoe factory."

Wilson earned his Ph.D. at Berkeley in 1940 under Lawrence. He worked on accelerators at Los Alamos during World War II, and subsequently built a series of them, including a ten-BeV electron machine, at Cornell. He speaks with great intensity and a trace of self-conscious nervousness, words and ideas spurting out one after the other in rapid bursts. His hair, which is brushed straight up in front above a rather flat face, seems the crest of a wave or the summit of an eruption. James Sanford, associate director for experimental planning at NAL, refers to Wilson's extraordinary "optimism about and enthusiasm for high-energy physics." The chief builder of the world's highest-energy machine is, appropriately enough, a man with a high-energy personality.

The decision to build a National Accelerator Laboratory was made in 1965. The lab was to be built and operated by a group of (by now) 52 universities organized as the Universities Research Association, Inc. and to be funded by the Atomic Energy Commission (AEC). The site wasn't determined right away and, tempted by visions of interstate prestige and high-technology industry, the officials of many states tried to grab the project for their own. Illinois politicians and public figures apparently shook the most hands and twisted the most arms; at any rate, the project went to Illinois. The state of Illinois then bought up the land on which the laboratory now stands for $28 million and donated it to the AEC.

Housing laws and priorities

Not everyone in Illinois was overjoyed by the turn of events; some people thought, for example, that one might find better use for 6,800 acres of the best farmland in the state. Outside Illinois, there was an outcry from people who thought it wasn't exactly progressive to build a huge permanent laboratory with government funds in a state that had no open housing laws. And everywhere some people had begun to worry enough about "priorities" to wonder if building yet another big accelerator was the best possible use for a quarter-of-a-billion dollars.

Illinois' lack of open housing laws stirred up the most indignation, and, Wilson recalls, "we felt very defensive about it." Laboratory officials pressured surrounding communities into passing open housing laws and set up an unusually aggressive minority hiring

Director Robert R. Wilson surveys with satisfaction a model of the Batavia complex, which he built a year ahead of schedule and without cost overruns.

A concrete tunnel houses the main ring's 1,000 magnets that guide the beam of protons. The tunnel of concrete (above) was then covered with earth.

program. In addition, to counter the more general opposition, the laboratory stressed the idea that its scientists were really humanists and environmentalists at heart—just the sort of people who would decide to keep a herd of buffalo around.

But the buffalo, and even the minority hiring program, are really peripheral to the laboratory's main function. They don't answer the basic objections that the NAL accelerator will probably produce nothing of immediate practical value to society or to any scientific field except high-energy physics and that $250 million is a lot of money for a racetrack for protons.

If, Wilson points out, the laboratory discovers the "magnetic monopole," which would essentially be a magnet that had only a positive or a negative pole, it will probably change the way in which electricity is generated. If it discovers "quarks," which have been postulated as the building blocks that form all of the 100 or so currently known subatomic particles, it will alter everyone's idea of the structure of all matter. Even so, he concedes, there is really no simple, logical way of dismissing those objections.

When pressed, he simply says that high-energy physics is basically a cultural activity and that the work of high-energy physicists has value to the nation in the same sense that the work of someone like Tennessee Williams does. It is largely a matter of faith: Either you believe in the value of that kind of research, or you don't.

If you grant the need for a NAL, it would certainly be hard to fault the way in which Wilson has done his work so far. Without exceeding the original cost estimates, the NAL accelerator has turned out to be more than twice as powerful as was originally planned, and it has been completed a full year ahead of schedule. The extra power is largely an accident.

Laboratory officials figured that a 200 BeV machine would cost $250 million and, Goldwasser says, "we felt that $250 million was the most we could responsibly ask for." So that's exactly what they did ask for,

and when they got it, they ordered the thousand-odd 13-ton magnets that would keep the protons moving on their course around the ring. But before the magnets were actually delivered, enough technical advances had been made so that basically the same magnets, at basically the same price, could produce twice the magnetic force. So they had a 500 BeV machine.

The early completion date was not an accident. "We've gotten it done so quickly," Goldwasser says, "by concentrating our money on the things that are necessary to make the accelerator run"—which has meant, among other things, resigning themselves to many more months in the little tract houses.

Although the accelerator really was finished a year ahead of schedule, there proved to be many a slip between having a machine with all its parts in place and having a machine that would actually run. The laboratory managed to send a beam of protons around the ring on June 30, 1971, and to send a beam "coasting" for more than 10,000 turns on August 1, but all the beams dispersed almost immediately.

People problems for protons

"I've gained an appreciation for the 'people problems' you encounter when you build something this big," Wilson says. On September 1, two full months after the scheduled starting date, Goldwasser explained that "somebody had almost certainly left a tool or a glove or even a sliver of metal inside the ring. That happens whenever an accelerator is built. But this ring is four miles long, and it's hard to find something in it." Then some of the magnets in the main ring required replacement, a task that was scheduled to be completed by Thanksgiving.

The delays were particularly frustrating because there was a mob of experimental physicists ready to go, breathing down the necks of the laboratory staff. Because of Wilson's "optimism and enthusiasm," 30 experiments had been accepted by the time the accelerator sent its first proton around the ring.

So far, more than 150 teams of physicists have applied to do research at NAL. Many of them have a real sense of urgency, because it's pretty well accepted among high-energy physicists that in this period of tight money, anyone who doesn't have an experiment scheduled at NAL may have trouble getting funds.

The earliest *big* experiment at NAL is the Cal Tech search for the intermediate vector boson. Ever since the 1930s, physicists have observed a "weak force" associated with radioactive decay, and they have postulated that the force can be explained as the action of particles called bosons—just as the recoil of a gun can be explained as a reaction to firing.The difficulty in observing the weak force is that it is almost always

The protons' path, a vacuum tube inside the giant magnets, is visible above; below, the main ring is complete. Repairs are speeded up by bicyclists.

found in conjunction with much stronger forces, so that its own effects are extremely hard to detect.

The best way to observe the weak force (at any energy levels except very low ones) seems to be by studying yet other particles called neutrinos, which have no other force associated with them. But precisely because neutrinos exert no stronger force, and because they are so small that at low-energy levels they barely exist, they too are almost impossible to detect. However, as Einstein discovered, the faster a particle moves, the bigger it gets, so that if you accelerate a neutrino to very high energies, it will get bigger and your chances of spotting it will improve.

Neutrino experiments have never before been pushed to more than about ten BeV. The NAL accelerator will push them to much higher energies. Goldwasser says, "The total number of neutrino events [detectable collisions between neutrinos and experimental targets] that have been observed in the world probably isn't more than a thousand. We should be able to observe a thousand neutrino events a week."

Three major neutrino experiments were proposed for the NAL. Cal Tech's was chosen, Sanford says, partly because "they could run it before all the lab facilities were finished."

The neutrinos in the Cal Tech experiment will be produced in the main ring and shot at a target in the "wonder building" nearly 1,000 yards away. The target stands on a concrete base three feet above the building's plywood floor (to begin with there was no floor at all, so everything that has been in the building for long is covered with a layer of dust). It consists of a row of big, green-edged square plates standing on edge. "The plates are made of steel," explains one of the Cal Tech physicists, Frank Sciulli. "Each one weighs two tons, and there are 40 of them. When you're using neutrinos, you have to have a target with a great deal of mass if you want to see any interactions."

A tiny but appreciable fraction of the high-energy neutrinos that come in will strike nuclei in the steel plates, and counting devices between the plates will record the numbers, speeds and directions of the resulting debris, which may include bosons.

All the data will be fed automatically into computers and then out to the Cal Tech researchers, who have tried to set things up so that they will get information as they go along, and not—as frequently happens in high-energy experiments—so far afterward that they've almost lost interest.

Finding the boson isn't the only object of the Cal Tech experiment, but, Sciulli says, "if we do find the boson, it will overshadow everything else."

Discoveries—the boson, the quark, the magnetic monopole and things no one has even postulated yet—are what everyone at NAL is looking forward to, and the whole laboratory is geared toward observing them. "The experiments that interest us are the most highly qualitative ones," Goldwasser says, explaining that quantitative experiments, in which people simply measure things that have already been identified, don't seem especially exciting when you're just entering a new range of energy.

When the first big accelerators began developing high energies in the 15 years after World War II, discoveries came thick and fast. Since then, with few exceptions, physicists have advanced by small steps, and they haven't advanced far. "Almost nothing exciting has happened in high-energy physics in the last ten years," Sciulli says; "certainly nothing like the excitement of the previous ten—and I wasn't in on that; I was still in high school during part of it. If you work ten years on something and just get this far"—he holds up his thumb and forefinger an inch apart—"you begin to feel you're banging your head against a wall."

Sanford, too, looks forward to recapturing the excitement of earlier research periods. "I was at Brookhaven for years before I came here," he says, and rattles off a long list of important experiments that were done at Brookhaven while he was there. Then he adds that none of them generated the kind of excitement that had apparently filled the place in the first few years after its 33 BeV accelerator started up. "The people who had been there in the beginning all seemed to have something *extra* in their professional lives. I think I and a lot of others came here to see if we could get that kind of experience in our lives, too."

Planners of the world's largest accelerator
hope esthetically pleasing power lines
(like good fences) will make good neighbors.

Smithsonian acquisition

Toys of yesteryear parade as of yore

A boy on a cast-iron tricycle and a messenger driving his clockwork three-wheeler lead the procession (right). After them come another motorcyclist, Mr. Tut Tut from Germany in his vintage auto, Kid Flyer, who is wound up by pulling a string, and a dogcart.

These six small vehicles and 2,854 similar items of the Sears, Roebuck and Company Collection of American Toys still delight children and elders with long memories at the Smithsonian's Museum of History and Technology, which has just acquired them.

These "Toys of Yesteryear" were gathered in America, but include many European models. They range from the era of the dogcart to that of the plastic racing car, reflecting the changing world. Cars evolve from horseless carriages to splendidly long-hooded tourers to the first "Airflow" to the day of the tailfin, right along with Detroit's whims. The past comes alive with horse-drawn fire engines, open-sided trolleys and double-decker Fifth Avenue buses.

You can also recapture the joys of the circus and the farm, the cap pistol and those wonderful little steam engines that hissed and sputtered and hummed and often scalded your fingers.

Turn-of-the-century traffic runs like clockwork

"Busy Lizzie" pushes carpet sweeper

Motorbike details are of stamped tin

"Sight-seeing Auto" is cast iron

Clowns hand-walk and play banjo

"Marx Merrymakers" date from '20s

Ferdinando Bibiena, *Piazza with converging streets.* This generalized backdrop, using his "angled view," was probably not intended for any specific work.

A royal chamber by Giuseppe Bibiena, Ferdinando's son. These colors looked like gold and silver in candlelight. Along with the one above, it was no doubt a stock set.

Fabrizio Galliari: an 18th-century working model of a Chinese garden scene for an unknown opera.

By William James Williams

It requires more than singers to make opera grand

A 400-year survey of Italian stage design shows that opera has always called for a wealth of talents—and just plain wealth

Mr. Williams is a museum curator at the National Gallery of Art and author of A Guide to the Galleries of the Minneapolis Institute of Arts. *Photographic copies are by Henry B. Bevell.*

Opera remains the most grandiose and expensive art form yet devised, for reasons—among others—that are made dazzlingly clear by an exhibition called *La Scala: 400 Years of Stage Design* that is now touring the country. A collection of more than 200 items from the Theatrical Museum of La Scala in Milan, it is being circulated by the International Exhibitions Foundation and opened at the National Gallery of Art in Washington in September. It is currently at the Indianapolis Museum of Art and will go on to the Detroit Institute of Arts (February 1-March 5) and the University of Texas Art Museum in Austin (March 18-April 16).

Despite its later emphasis on the spectacular, opera had very staid and intellectual origins. Renaissance scholars, in their enthusiastic examination of classical antiquity, decided (whether rightly or wrongly is beside the point) that the ancient Greek drama had been sung rather than declaimed. What is now regarded as the first true opera, Jacopo Peri's *Dafne,* was performed in a Florentine nobleman's palace in 1597 and was simply an effort to re-create Greek tragedy along these lines.

The aristocratic audiences who saw this and sim-

Gaspare Galliari: Bold and dramatic, this interior for an opera requiring a prison scene shows a change from 18th-century rococo.

Ippolito Stefanini: Ruined castles, such as this one for *Lucia,* were a staple of romantic opera design.

Carlo Songa: realistic setting for *Carmen*. Georges Bizet, like other composers of his time, was very specific about the kind of scenery he wanted.

ilar productions were familiar with the classical myths on which they were based; there was no element of suspense or surprise, and the intent at first was moral edification as much as entertainment. The earliest operas were essentially serious and their scenery appropriately majestic and austere. The settings were built at one end of a great hall in the palace, and scenery changes were minimal; freshly cut branches scattered about the stage were often sufficient to indicate an outdoor locale. But as these musical dramas quickly became the principal element in court festivals, princely patrons began to vie with one another in staging ever more sumptuous performances. The evolution toward sensationalism had begun.

No one played a greater role in the changes that followed than Ferdinando Bibiena, a Bolognese architect and designer. His chief innovation was the "angled view," a backdrop painted so that the audience looked down diverging avenues or into the corners of rooms (page 38). More dynamic than the straight-on symmetry of Renaissance sets, Bibiena's exterior scenes suggested immense vistas, while his interior settings tantalized the audience with hidden nooks and crannies.

Artists all over Europe were soon copying Ferdinando's concepts, and his numerous sons and pupils dominated stage design during the first half of the 18th century. Respected and highly paid, the Bibienas were competing with such notables as the architect Filippo Juvarra and Madame de Pompadour's protégé, the painter François Boucher, who served the Paris Opéra as designer for six years.

These 18th-century stage sets were often constructed with three-dimensional ornamentation in plaster or papier-mâché, as were the more fantastic examples of actual interiors. In an age more concerned with spatial effects than with engineering integrity, the curving walls of Italian salons and the elaborately vaulted ceilings of German rococo churches were, like stage décor, merely plaster shells suspended by ropes from ordinary wooden-beamed ceilings.

Theaters in the 1700s were equipped with ingenious machinery for producing spectacular effects and transformations, thus creating difficulties for current revivals of the operas of Handel and Gluck. Productions often required as many as 20 scene changes, plus the visual counterfeits of earthquakes, fireworks, floods, holocausts or celestial apparitions. Financing such extravaganzas today would be out of the question, but since opera was the most complex theatrical

expression of the 18th century, no expense was spared.

With occasional touches of blue sky, rococo opera scenery was usually painted in tones of gray and sepia (page 38). Under the flickering glow of candlelight, rich colors would have disappeared and all surfaces would have seemed insubstantial. But that same warm glow lent a gold and silver luster to the browns and grays in Bibiena designs. As these operas invariably dealt with mythological and legendary themes, their otherworldly aura was enhanced by the shimmering dance of candle flames over substances that had been magically transformed into precious metals. And all this fantasy could glitter with jewels when tinted glass lenses or bottles of colored water were placed in front of the candles.

The auditorium remained lit during performances; the extra candlelight was needed for stage visibility, and the social aspects of aristocratic patronage directed as much attention to the audience as to the performers. Indeed, gaming and dining tables were frequently found in 18th-century boxes. The lavish ornament of the theater was not merely embellishment, however; the excellent acoustics of rococo opera houses is due in no small measure to the dispersal of sound by gilt cupids and candelabra.

By the mid-18th century, the humanism of the Enlightenment was bringing opera plots down to earth, transforming the idealized gods and heroes into fallible mortals. Scenery designers followed suit. The audience could not be expected to believe that the very real city of Seville in Mozart's *Don Giovanni* was some never-never land of gold and silver. Military camps, rustic cottages, city markets and Chinese gardens (page 39) soon replaced the Olympian temples and idyllic glens of earlier operas.

Stronger contrasts of light and shadow as well as natural colors were required; fortunately, a new light-

Carlo Ferrario: His Druid sanctuary for a late 19th-century production of Bellini's *Norma* typifies the overloaded detail of "Victorian" opera sets.

ing method was devised which allowed the audience to see the subtlest modulations of hue. The Swiss scientist Argand invented his improved type of oil lamp with burner and chimney in 1784; its bright, unwavering and adjustable illumination marked the first major improvement in theatrical lighting since the beginning.

During the social upheavals following the French Revolution, opera often became a vehicle for nationalistic or patriotic sentiments. Most of the plots during the first half of the 19th century were drawn from popular history and folk legends. Their very titles indicate a preoccupation with liberty and rebellion: *William Tell, I Puritani, Les Huguenots.* Even the comic operas, such as Rossini's *Barber of Seville,* dealt with social issues and class distinctions. In 1830 a performance in Brussels of Auber's *Masaniello,* with its revolutionary theme, set off a riot that triggered the Belgian revolution.

Loosely termed "grand operas," these productions sought to impassion the spectators with frenzied ballets, mob scenes and vocal pyrotechnics. The combination of newly effective lighting with more emotional plots fostered scenery that was overwhelming in scale and brightly, even garishly, colored. Moonlit, ruined castles are veritable hallmarks of grand opera (page 40). Since they accompanied quasi-historical stories, the stage designs had to be more archaeologically accurate to reinforce the believability of the plots.

Political changes altered not only the plots but the patrons of opera. With the spendthrift aristocrats out of the picture, the tightfisted merchant bourgeoisie became the subsidizer of this most expensive of the arts. With less lavish financial backing, the productions had to be cheaper. The painted backdrop and canvas flats had long since taken over from costly three-dimensional scenery. Properly lit by Argand lamps or gas lights, the two-dimensional backdrop can create an effective illusion of reality. Only the awkward junction of the painted fabric with the stage floor presented a problem, and that unsightliness could be easily masked behind artificial shrubbery or a few pieces of furniture.

As the 19th century progressed, a tendency to overly intricate detailing developed in opera scenery—an expression of Victorian or Second Empire high taste (pages 42-43). This manic proliferation of detail was partly due to the ever-increasing ability of the audience to scrutinize the scenery. By mid-century it had become customary to dim the houselights during a

Antonio Rovescalli's set for Mascagni's *Iris* imitates the style of Japanese prints.

Opposite: Giambattista Santoni's 1927 design for Act I of Richard Strauss' *Der Rosenkavalier.*

performance; with the auditorium obscured, all eyes would be drawn to the lighted stage. By this time the harsh white glare of the calcium lamp, or "limelight," made possible the use of focused spotlights. Gas, in general theatrical use by the 1860s, permitted the development of a master control board for sophisticated lighting programs. Finally, Edison's perfection of the incandescent bulb was first applied to the theater in 1880-81 at the Paris Opéra; by the end of that decade every major stage in the Western world was lit by electricity. Since theatrical illusions and moods are totally dependent on the effectiveness of the illumination, experiments in stage lighting continue to this day.

In the world of Dickens, Marx and Freud, opera began to concentrate on the essential motivations of its characters. To replace spectacle with intimacy, late 19th- and early 20th-century composers carefully stipulated their own requirements for stage action and settings, thereby reducing the designer's scope for pure invention. Bizet's *Carmen* is a case in point (page 41). The more naturalistic operas often required believable domestic interiors, like the one for *Iris* (page 44), which could serve just as well for *Madame Butterfly*.

The small-scale works of Alban Berg, Gian Carlo Menotti and Benjamin Britten pose a peculiarly modern dilemma: how to create a personal interplay between two or three characters on a stage that is big enough to accommodate the triumphal march in *Aida*. The usual solution is to close the stage down to domestic scale by inserting a smaller, false proscenium around the edges of the stage opening. Careful attention to sight lines is necessary to insure that the smaller stage will be visible to the entire audience.

Thrust staging and opera-in-the-round have created new challenges for scenery designers, but solutions to these problems are not included in the present exhibition, which does not come much past World War I. La Scala is an opera house of traditional design, as are the new Metropolitan in Lincoln Center and the one in the John F. Kennedy Center for the Performing Arts in Washington (see page 22), and opera there tends to be presented in traditional ways.

This exhibition from the Theatrical Museum of La Scala is, in fact, being circulated as a salute to the Kennedy Center. It includes, in addition to the large number of scenic designs, nine model stage sets from the 18th century, some costume designs and a group of operatic posters. And it proves, for those who like their opera grand, that they have a 400-year tradition to back them up.

Aunt Arie Carpenter copes with questions from
Foxfire interviewers before they share her "rations."

By Peggy Thomson

Old-timers tell all to *Foxfire*

A school journal in the Georgia hills, staffed by students, has become a sounding board for local folkways

Fog bowls through Rabun Gap in northeastern Georgia most mornings and hangs over the Rabun Gap-Nacoochee High School, the post office, the carpet factory, the highway lined with gas stations and beer joints. It blots out Pickens Nose and all the lesser ridges running north into North Carolina, east into South Carolina. It shreds a bit for the sun to shine through, leaving the oak woods aglitter and the red clay roads winding up from the valley slick as grease.

The high schoolers are out on the job these foggy mornings with their jeep, lurching up the mountain roads in quest of conversation with old-timers in quiet coves—self-sufficient quirky men and women with tales and talents to fill a book. A book, in fact, is coming out in January. Its chapters were gleaned from articles done for their first-rate folklore magazine, a quarterly called *Foxfire*.

Foxfire started when a new young English teacher, B. Eliot (Wig) Wigginton, facing classrooms of bored students, asked if they knew how to build a creek-rock fireplace, dig ginseng root, brew a boneset tea. They didn't. But they found out and recorded their discoveries in a straightforward conversational way, most of it in the dialect of the subjects they interviewed. Some of what they learned was from their own grandparents, but most of it came from strangers who cleared their gardens from wilderness filled with wildcats, bear and painters (panthers) and lived off hogs that grazed on the mast of the forest, back when the ground was black for miles with chestnuts.

Today, into its fifth year and sixth set of jeep tires, their magazine goes to 4,000 far-flung subscribers ($5 a subscription), and the students—as many as 50 have a hand in it—handle every phase of the operation. In offices in the school building they transcribe tapes, edit, prepare layouts for the printer. They take care of circulation and correspondence, totting up checks, accepting an Alaskan farmhand's offer of wild raspberry leaves for tea in lieu of payment. Stacked ready for typing are definitive articles on burials, bee gums (hollow gum trees) and granny women (Southern Appalachian midwives) for a coming issue.

In past issues the staff has covered such things as how to build a foot-powered lathe, plant by the signs or stitch a Drunkard's Path quilt. One story requires another. How to split white-oak splints for chairs led to how to split white-oak logs into boards and shingles, how to dress them using a shaving horse, how to make the shaving horse, how to snake logs out of the woods.

Begun to enliven high school English, the quarterly is now independently supported by grants.

Peggy Thomson wrote about the Institution's "frozen menagerie" in last May's SMITHSONIAN

Foxfire's *staff in action*

Aunt Arie shows Beulah Perry (center) and Mary Garth how to make one of her bow baskets.

One article on "The End of Moonshining as a Fine Art" ran for 80 pages, complete with a glossary of 28 terms, lists of how to hide a still and how to find one and recollections from the sheriff and some of the men he caught. The students attended three hog-slaughterings and put four months into researching the ways to cook a hog, from feet to snout. "Lot o' people throwed away that they called the rooter," one source told them. "Oh, I forbid that. I'd rather have that as any part."

Recipes are a feature: crock grapes, leather breeches beans and chitlins. So are home remedies: A roasted poke-root poultice applied to a "black 'risin' " will draw it out and leave the skin white as cotton.

Foxfire-trained students, tuned to mountain language, savor the eloquence in it. They go helpless with hilarity listening to the tape of Wig's first meeting with Aunt Arie Carpenter. He came upon her wrestling with a hog's head on her kitchen table, unable to pry the eyeball out (her knife dull, her hand no longer "stout")—so Wig took over the job. On that occasion they let their machine run the 40 minutes he worked at it and made a story of Aunt Arie's exhortations and advice, to the moment she pitched out the eyeball.

A hard core of the magazine's staff stays on at school during the summer to stockpile material. The writer tagged along with them while they worked.

Tuesday afternoon, we visit Annie Perry, a tiny wisp of a woman living in the split-log house where she was born. Mrs. Perry, in a print dress, squashes a straw hat on her head and leads us nimbly through the garden where she is eye-level with her dahlias, dwarfed by her sunflowers and corn. She remembers her first garden, in the same spot—four rows of onions, four of beans.

Mrs. Perry sits on her porch, the afternoon light sifting through her pink-blooming mimosa onto the box of baby chicks she's sunning against the rickets. She snaps half a bushel of beans as she talks. Along with her neighbors she believes in planting by the signs. Her beans would be "specky" and they'd have the rot if she'd planted them when the signs were in the bowels (Virgo). Corn would be rotten, too, shoot up too tall with tiny ears on top. You plant it when the signs are in the arms (Gemini). You kill a hog when the moon is shrinking—"the meat won't puff up then and be big ol' thick pieces and the chitlins soggy."

Next day two of the boys head the jeep 50 miles into North Carolina to seek out Grade Burnette—and a story on making a wagon wheel. Grade, who lives by Turkey Branch, is cordial but he's long out of practice; his eyes fog up on him, he says, and he's uneasy about the job. Through a long afternoon the boys visit with him, playing with his dogs, watching his hummingbirds in the nasturtiums. They offer to do the work if he'll direct. Grade gets to talking about the wagon his dad made ("Hit tuck him a hard two months,

purtiest wagon ye ever did see")—talking, too, about "the awfulest wagonloads we use' to haul out of that cove up yonder with a team of mules, the spokes just a-snappin' an' a-poppin'—chestnut logs we hauled an' tanbark for makin' the tannin' ooze."

Driving home, the boys take note of two new story ideas: one on mandolins (Grade's brother makes them), another on how Grade makes banjo heads—he skins a groundhog, lays it ten days in ashes until the hair slips off easily, then soaks it in buttermilk.

Thursday, even with the rain, is a major production at Sam Burton's place at the foot of Goshen Mountain. It's the first of four days on a story about the tub wheel—a small mill wheel, powered from a sluice, that revolves horizontally on a pine knot with a shaft running up from it to grindstones in a mill above. Sam, who used to ride such wheels as a boy, hanging on the shaft pin, learned to make them from a neighbor, Grandpa Watts. He agreed to make one for *Foxfire*.

That day a full magazine team spends ten hours with him, recording every step from the start, when Sam has a huge wood block, to the day's finish, when a 36-inch diameter wheel is pierced all nine inches through, with the first of its eight "buckets." In a circle around Sam, Laurie and Dave are clicking cameras; Wig stands ready with a shoulder when the block needs upending; Mary takes notes on measurements. Mike, backed off a way, has the video tape recorder to his eye. Jan points the extension mike to catch Sam's mutterings as he works: "I'd rather it was yellow poplar, soft, you can dip it out with a spoon, but this white pine'll do. Sand in the water beats itself right into soft wood so it gets to be sand grindin' on sand. Last five times longer'n oak. Sand'll grind that oak down in no time at all."

Coming home to Aunt Arie

The kids get it all down—the two chunks of wood as they become a square, with dowel pins hacked from a locust fence post, the square as it's rounded off by Sam standing barefooted on its face, swinging at the corners with his ax. There's little talk, except from tree frogs, supposedly calling for more rain. Chopping sounds, mostly, and the chink of hammer on chisel. It's after eight when kids and craftsman, ankle deep in fragrant shavings, say good-bye. And just before dark the sky clears, lighter than it's been all day.

The Friday visit to Aunt Arie—an often-quoted source—is a homecoming. Every peril of the road is as familiar as the welcome up at the big log house with its corded beds and feather ticks, crocks for churning and for bleaching fruit, old brown photographs on the wall ("Ulysses and his first wife, taller'n him a mile"), the Bible in the parlor by the *Foxfires,* with the fan letters tucked inside—and one frail-looking woman with a paralyzed hand trotting in and out and about. " 'Ulyss' always laughed at me for trottin'. How he laughed."

The students are rushed at by Aunt Arie with a stream of greetings, domestic news and gossip, her dipper still in her hand. She's dousing her cabbage on the woodstove with souse broth, poking corn and potatoes and beans and sausage, mixing up pan bread, unwilling to concentrate on basket-making—object of the visit—until dinner with her guests.

"Here, I let my fire go smack out. You'd think I'd learn." The boys take the cue. "Cooked for ever' one since I climbed on a stool to sift flour. I 'as all the gal they was. Four brothers—and I waited on 'em the way ye do, but they kept the fire goin'. My mommy never let me lift a ax to chop the stove wood. One lick 'r two, she'd be after me. It's all in what you're raised to.

Lon Reid spoke shaves a chair leg. It takes a Jeep to drive into his isolated mountain "cove."

Thank ye, boys. I wouldn't take a war pension for nary one o' ye. Honey, are ye lookin' to the bread?"

Fed, the young fan out, some to set up equipment, some to do chores. Aunt Arie gets her pupils started on the porch, learning to make one of Aunt Arie's bow baskets. But the teacher is restless and trots off again—out to her beans where the boys are weeding, to the well where Laurie's doing dishes, to the "snaky" potato patch. "Ain't only one thing I'm scared of, that's snakes, and I've killed 17 here in a summer."

Fame has touched *Foxfire* in pleasant ways. Two $10,000 grants from the National Endowment for the Humanities have paid for jeep, cameras, recording and video equipment, an ex-Vista editorial assistant, summer salaries and week-long student exchanges between this staff and those of magazines that it has inspired. The students have collected awards and invitations to speak, as well as acclaim in the national press—from *Saturday Review,* from the *Whole Earth Catalog,* which said *Foxfire* was a "wonderfully real publication" next to which "most underground papers seem written by children shrieking at Daddy." And the seniors are welcomed by colleges.

According to their master list of story ideas, the student journalists don't have to worry about running out of material, at least for some years. But there's an urgency in the fact that their sources are mostly in their eighties. "It's sad we're reaching them so late. Many haven't built these things for 20 years. They've misplaced tools or lost them to tourists."

The only concern is that success will spoil some of the fun. If the book sells as Doubleday expects it to, subscriptions may increase tenfold. And a lot of jobs that have been done by volunteers, like hand-addressing the envelopes and blanketing the corridors with packets sorted by zip codes, will have to be turned over to agencies. Another companionable occupation will have vanished along with quiltings, barn raisings, corn shuckings, pea thrashings. Already the magazine has resorted to printed rejection slips.

Together, Wigginton and his kids see a bundle of possibilities. They may start a totally different student magazine that would investigate highway developments, housing, that sort of thing. Wigginton, who will be teaching part-time, has become an associate with Ideas, Inc., in Washington, D.C., for next year.

The students themselves are plotting ways to return to Rabun Gap as college graduates, maybe with the museum for which they've helped Wig draw up plans. It would have a central gallery with a complete log cabin under its roof, a workshop wing where community people and tourists could quilt or make a chair, a library wing for films and tapes.

The Georgia Commission of Arts would like to see it and is looking for funds. And it's no more unlikely than that a bunch of youths in a remote corner of Georgia would have a nationally successful magazine on their hands—named *Foxfire* for the soft glow Huck and Tom used to dig by when a lantern would have been too bright.

Sam Burton drills "buckets" in a water-powered tub wheel while tape recorders hum and cameras click.

Eratosthenes shows fellow scholars at the Museum in Alexandria the method he used to measure the Earth's diameter. His estimate, made in the third century B.C., was off by less than one percent.

Paintings by Nicholas Solovioff

By David E. H. Jones

The great Museum at Alexandria: its ascent to glory

First of two articles on the Egyptian marvel of learning and invention that radiated Hellenism's spirit through the ancient world

In the third century B.C., a king founded a research institute to enhance the prestige of his regime. He did well, for in the course of its investigations, the diameter of the Earth was estimated with less than one percent error, a mathematical textbook was written which for upwards of 2,000 years was the acknowledged masterwork of its subject, and the first steam "engine" was built.

The king was Ptolemy I of Egypt, the place was Alexandria on the Nile delta, and the institute was the Alexandrian Museum. It was, as far as is known, the first scientific research establishment in the world.

To understand the place of this amazing institute in history, we must go back to 338 B.C., when the classical Greece of Plato and Aristotle was conquered by Philip II of Macedon. The Macedonians well knew the cultural eminence of the people they had conquered, and were uneasily aware of themselves as barbarians in comparison. Even before the conquest, Philip had called Aristotle himself to be tutor to his son, Alexander.

This Alexander, shortly after gaining the throne in 336 B.C., began the meteoric career of conquest which earned him the title of Alexander the Great. Perhaps Aristotle had raised Alexander's ambition above the gangster level of most commanders, for the conquests

In the first of two parts, Dr. David E. H. Jones, a noted British journalist and a research scientist, traces the spectacular scientific and literary accomplishments of the early Hellenistic scholars of Alexandria.

The Alexandrian Museum: Part one

of his Greek and Macedonian army were not merely a plundering expedition but partly, in effect, a crusade to spread his adopted Greek culture. He even sent back to Aristotle specimens and accounts of natural phenomena encountered in his travels.

The huge and unwieldy empire he carved out in 11 brief years of brilliant campaigning stretched from Greece to India and from Africa to beyond Afghanistan, so that at his death at the age of 32 he was nominal ruler of most of the known world. Just one of his many lightning conquests was that of Egypt where, as was his custom, he selected a site for his capital, Alexandria (one of at least 17 cities to receive his name in this way). He left a skeleton administration with orders to build a major city, and set off again on his relentless campaign. He died, still soldiering, in 323 B.C., never having visited the site again.

At once the vast Macedonian empire began to crumble as the potential successors fought and intrigued among themselves. Ultimately, after 40 years of complex treacheries, the empire settled back very much into its previous stable divisions: the Greek provinces, the Eastern provinces, and Egypt and Libya. Yet the sheer audacity and scope of Alexander's conquests forbade things ever to be the same again.

The massive dispersal and flux of Greeks as the empire rose and decayed again, broadcast the distinctive Greek culture, its institutions, its art and science and values, throughout the known world. Greeks everywhere settled and began to reproduce their way of life in alien territories, knowing that other Greeks were doing the same elsewhere, so that Alexander's empire lived on in the Hellenistic civilization it had dispersed. Ultimately the Hellenistic plant withered, slowly stunted by the stony soil of the indigenous cultures in which it had been planted and choked by the spreading growth of Rome; but for a time—roughly from the death of Alexander to the birth of Christ—it flourished and blossomed. The Museum at Alexandria was one of its most magnificent fruits.

In the bloody lottery of the imperial collapse, Egypt and Libya fell to Ptolemy, a general of Alexander and possibly his half-brother. He was an extraordinarily able and astute politician—as shown by the fact that the dynasty he founded was by far the stablest of the imperial fragments and that of all the rival successors he was the only one to die in his bed. He consolidated his regime with great thoroughness, establishing a great bureaucracy to tax the agricultural wealth of the Nile valley, and poured much of the profits into his magnificent new capital of Alexandria.

Alexander had chosen his site well. With two sea harbors and access to the Nile it stood at the crossroads of the Near Eastern trade routes and soon became a focus for exchange of Egyptian, Arabian and Mediterranean goods. And it was built in the grand manner.

Alexandria was constructed entirely of stone, a fact which was to be important in its survival of the many disasters of its later history, and it became a cliché of the ancient world to extol its grandeur and magnificence. But Ptolemy, as befitted a Hellenistic ruler, was not content to have the richest and showiest capital he could afford; he wanted it to be culturally preeminent too. He had not only to attract Greek merchants and administrators to his fine city, but artists and thinkers as well. He decided to found a library and a philosophical college.

A temple of culture for Ptolemy

It is worth pausing to appreciate the astonishing implications of this decision. This man Ptolemy is a dictator. He has spent 12 years, ultimately as a general, helping to carve out an empire by military might and 20 years in political intrigue and mercenary warfare to seize and hold a rich fragment of it. Yet as soon as his borders are relatively secure, he seeks prestige and reputation by becoming a genuine and generous patron of literature and pure science.

More interesting still, Ptolemy was not unique. He was not better or worse than the other rulers of his day: They were all dictators, holding their regimes, inevitably, by main force. Nor were his cultural ambitions unusual.

Other kings were also striving to establish libraries and artistic colonies on their territories. The Hellenistic spirit, spread by Alexander, had thrown up rulers with a whole new outlook on the problem of what to do with power once you have seized it. But of these, Ptolemy had the great good fortune to be guided in founding his cultural center by two men from Athens: Demetrius of Phalerum, a political refugee, and Strato

Math for math's sake: Amid practical inventions like the water clock (at right), Apollonius and others studied the geometry of conic sections, helping later astronomers to understand the elliptical orbit.

of Lampsacus, a physicist. Demetrius was ex-governor of Athens, deposed by a coup in 307 B.C., and Strato had accepted the post of tutor to the crown prince Ptolemy II.

Though its political importance had gone, Athens was still a philosophical center boasting famous colleges like the Academy, founded by Plato, and the more recent and scientifically inclined Lyceum, founded by Aristotle, and of which both Demetrius and Strato were illustrious alumni. It was their advice that shaped the Museum as a descendant, so to speak, of the Lyceum at Athens. But the uniquely scientific character of the Museum must be due to Strato. He was called "the physicist" because he devoted himself to the most careful study of nature and of metaphysics.

The word "museum" has been altered in the course of centuries. Nowadays it often implies a collection of historic exhibits, a monument to past achievements. But to Ptolemy it meant a temple to the Muses, the mythological patron goddesses of artistic creativity and understanding; and indeed for all its scientific work the Museum seems to have been nominally a temple, with an Egyptian priest in charge of it. This was probably a political accommodation with the local religious hierarchy.

Together with its sister institution, the great Alexandrian Library, it was housed (when the imposing buildings had been completed under Ptolemy II) in the royal quarter of Alexandria, the Bruchium. This occupied perhaps a fifth of the original city area and contained also the Royal palaces, temples set in spacious grounds, and the Soma, the ornate tomb of Alexander (whose prestigious remains had been seized by Ptolemy I in a typically shrewd move early in the wars of the successors). The Museum was equipped with lecture halls, covered walks with seating for informal conversations, a refectory for the staff, laboratories for dissection and scientific studies, and botanical and zoological gardens. Both scientists and Library scholars lived on the premises as part of the king's household, were paid and supplied by the state and engaged in their work full time, often with the active aid and interest of the king.

Brilliant men backed by power and wealth

Together the Museum and Library, backed by the power, wealth and stability of the Ptolemaic regime, attracted brilliant men from all over the classical world—just as in a later age the aggressive and cosmopolitan intellectual centers of America were to gather scientists and scholars from the relatively impoverished and more traditionally organized academic world of Europe.

Bertrand Russell once recalled an enthralling encounter with mathematics, a boyhood geometry lesson from his brother. The lesson began with axioms which "can't be proved, but they have to be assumed before the rest can be proved." "Why should I admit these things if they can't be proved?" said the young Russell. "Well if you won't, we can't go on," replied his brother; and Russell, all agog to see how it went on, admitted them for the time being.

This charming anecdote illustrates not only the early skepticism of the 20th-century philosopher, but also the enduring authority of the textbook he was using—Euclid's *Elements of Geometry* written in Alexandria some 2,200 years before. Euclid seems to have been called by Ptolemy I to head the mathematics

The Museum (foreground) was completed under Ptolemy II; the Library is to the rear. Though there is disagreement over details, this painting was constructed from the most plausible sources.

faculty of the Museum, though his best work may have been done before its formal organization was complete. We know little about him as a person, but he wrote on mathematics, optics and astronomy, and the school he founded produced other brilliant mathematicians whom we will encounter presently. But all his other achievements are dwarfed by the *Elements,* the greatest mathematical treatise ever written.

Euclid did not invent the wonderful idea of proving mathematical statements; that step was probably taken by Thales of Miletus 300 years earlier. Nor did he discover all the theorems in the 13 volumes of the *Elements,* though a large number must be his alone. His achievement was to take the scattered propositions of geometry and build them, proof upon proof, into a unified and irrefutable structure.

From a few simple axioms Euclid derives, link by link, every proposition in his geometry. If you can't prove it, you don't know it, challenges the *Elements,* and ever since, men have taken it for a model of what systematic knowledge ought to be. Ever since, the admitted business of mathematics has been proving propositions from basic axioms. The very terminology of Euclid's *Elements,* its theorems and corollaries and lemmas, are still part of every mathematician's working vocabulary.

The most illustrious alumni of the Euclidean school at Alexandria were Archimedes, the greatest mathematician of antiquity, and Apollonius of Perga. Archimedes studied at the Museum about 260 B.C., before returning to his native Syracuse in Sicily to continue his work. We can only glance at his achievements here—the science of hydrostatics, which he invented by himself and developed to incredible elaboration; his practical inventions like the Archimedes screw (familiar to all modern engineers) which he invented at Alexandria, and the great war machines with which, according to legend, he held at bay an entire Roman army for three years during the siege of Syracuse; above all his masterly mathematical proofs which at times anticipate the integral calculus.

Apollonius of Perga, "the great geometer," came to Alexandria from Palmyra about 240 B.C. to work in the mathematical school and is famous for one outstanding treatise, the *Conics.* We are fortunate to possess many writings of these men, not merely formal monographs but explanatory prefaces and letters, like those written by Archimedes to his friends Conon and Eratosthenes in the Museum. Such letters reveal a wonderful spirit of intellectual community among the Hellenistic scientists; even though separated by weeks of traveling time, they share a common culture and goal in an open, courteous exchange of ideas.

Archimedes and Apollonius were both active in the field expounded in the *Conics*: the geometry of the different cross-sections which can result from sawing at various angles through a cone. At first sight, this may seem the most absurd mathematical pedantry.

Even Euclidean geometry had serious practical applications in engineering and surveying; but what possible interest can there be in sawed cones? To the Alexandrians, such questions would have smacked of boorishness. Their mathematics was an art, a thing of elegance giving eternal truths about changeless and ideal entities, and they pursued whatever topics seemed to them promising.

And, in this case, their intuition for the fundamentals of their topic was sound indeed. Even 1,800 years later, the works of Apollonius and Archimedes were to be catalysts of new mathematics and new astronomy. When Kepler in 1600 was wrestling with Copernicus' bold idea that the planets, including the Earth, move around the sun, he was able to fit each orbit to an ellipse—a conic section. And later Newton's gravitational theory showed that every simple celestial orbit had to be one or other of these conic sections which had been investigated for their own sake in Alexandria all those years earlier.

Not only did the Renaissance astronomers borrow Hellenistic mathematics—they borrowed Hellenistic astronomy. One of the most amazing facts in the history of science is that Aristarchus of Samos, an astronomer of about 310-230 B.C., advanced the Copernican hypothesis that the sun and stars are stationary while the earth spins on its axis and orbits the sun. Aristarchus seems not to have been a member of the Museum; he was a pupil of Strato, but probably while Strato was at Athens. There was no predominant astronomical college in the Hellenistic world; observations were made in a variety of places including Alexandria.

Aristarchus' wonderful guess was much too far ahead of its time to be accepted—indeed one Cleanthes of Assos advocated bringing a charge of impiety against him—and the traditional belief in a static spherical Earth surrounded by moving heavenly bodies prevailed. But another of his achievements is important for our story. He invented and put into practice a method of comparing the sizes and distances of the moon and the sun which revealed the unexpected immensity of the heavens. Later Hellenistic astronomers refined his method and arrived at practically the true values for the moon's distance and size, but never obtained good results for the sun, for it is too far away for any naked-eye method to work well.

Measuring the Earth and mapping the body

To complete these measurements, the size of the Earth had to be determined, and this was definitely achieved at the Museum by Eratosthenes.

Eratosthenes was an all-around scholar in an age of increasing specialization. Educated at Cyrene and Athens in literature and geometry, he was called in about 240 B.C. by Ptolemy III to Alexandria, where he became tutor to the crown prince and librarian of the great Library. He did good work in literary criticism and mathematics but his fame rests most surely on his contributions to geography and history. His measurement of the size of the Earth was the first and necessary step in scaling his world map.

He calculated that when the midsummer sun was at its height in Alexandria, a pointer fixed at the zenith cast a shadow equal to one-fiftieth of a whole circle, whereas far to the south at Syene (where the Aswan dam is today) the sun was exactly overhead. He therefore asked Ptolemy to command the state surveyors to measure the distance from Alexandria to Syene—a good example of Ptolemaic cooperation in the research of the Museum, for the distance of about 500 miles had to be paced out by men trained to walk in uniform steps and count them.

After a number of measurements, Eratosthenes gave the circumference of the Earth as 252,000 Egyptian stades. Adopting the most likely value of the

stade (516.73 feet), this is 24,662 miles, compared to a true value of 24,817 miles. This astonishing accuracy is at least partly good luck, for two important errors canceled themselves out. But the method is sound, and provided a basis for Eratosthenes' world map.

It represents the Mediterranean region remarkably well, considering the difficulty of constructing it from the reports and travelers' itineraries in the Library, which were all Eratosthenes had to go on. The more outlying areas are, inevitably, less accurately figured. But the most important single feature, only revealed by prior knowledge of the size of the globe, was the small extent of the known world on the Earth's surface. Indeed, it may have been Eratosthenes who first suggested the existence of another continent in the vast ocean between Spain and India.

From making cosmic measurements we turn to mapping the "microcosmos" as the ancients called it: the "little world" of the body. The medical faculty of the Museum was one of its chief and most enduring glories; even five centuries after its founding, to have studied in Alexandria was the highest recommendation for a doctor. But the most dramatic advances were made by the founders of the medical faculty, Herophilus of Chalcedon and Erasistratus, a list of whose discoveries reads like a textbook of anatomy.

The intellectual freedom of the Museum enabled them to dissect corpses, which, though essential for anatomical knowledge, had previously been hindered by fear or religious taboos. Like other explorers, they had to invent names for their discoveries; some of these (*e.g.* epiglottis, retina, duodenum) are essentially the ones we use today.

Herophilus first recognized the connection between the heartbeat and the pulse, distinguished between arteries and veins, and reinstated the brain as the seat of intelligence (Aristotle had said it was the heart). Erasistratus, the younger man, was more of a theorist. He realized that every organ in the body is plumbed into the system by three sets of vessels, veins, arteries, and nerves—and he divided these into sensory nerves (carrying information from our senses) and motor nerves (carrying orders to our muscles). He also guessed at the capillary network connecting arteries and veins, and discovered some aspects of the circulation of blood.

In the spring of 1900, a party of sponge-divers off the small Greek island of Antikythera came across an ancient wreck in 200 feet of water. From the style of the marble and bronze statues and other objects removed from her, the workers at the Greek National Archaeological Museum at Athens deduced that she had foundered in about 65 B.C. They were amazed to find, among the corroded clumps of metal slimy from 2,000 years spent in salt water, a fragment of complex mechanism. Patient cleaning and restoration of this "Antikythera mechanism" reveal an astronomical calculator. By a complex set of gear trains leading through an epicyclic turntable still not completely reconstructed, it showed the motions of the heavenly bodies and the calendar on a series of pointers. Its setting corresponds exactly to the calendar of 80 B.C.

The Antikythera instrument shows the Hellenistic mechanicians in quite a new light, for nothing in the surviving writings of the time prepares us for such sophistication. In particular the three Museum mechanicians we know of—Ctesibius, Philo and Hero of Alexandria—though they clearly understand the use of gears, pulleys, levers and other basic mechanical elements, illustrate their treatises with much simpler examples. Ctesibius and Philo probably lived around 300-230 and 250-180 B.C. respectively. Hero seems to have flourished much later, in Roman times (an eclipse he used to calculate the distance from Rome to Alexandria occurred in A.D. 62) but he is so akin to the others as to merit discussion with them.

A steam "engine" and Greek grammar

All three men devoted part of their energy to serving the state, devising catapults and other weapons; Philo in particular wrote a comprehensive treatise on the engineering arts of offense and defense. Their peaceful researches are far more entertaining, however, for these men had a fine sense of the charm of mechanism and spent much time devising animated tableaux, musical works of art and other delights.

Ctesibius, who is one of history's great inventors, created such devices as a constant-flow water-driven clock, the force pump and the air pump, and developed the latter into the very first keyboard musical instrument, a water organ.

With its excellent harbors, Alexandria was at the crossroads of the world. The Museum and Library were erected in the ancient city's royal quarter, a library addition housed in the Temple of Serapis.

Philo and Hero developed these inventions further and elaborated the theoretical physics of air and water to explain them. Air, says Hero in his treatise, *Pneumatics,* is a material substance consisting, like all material substances, of particles in a vacuum. It can be compressed or rarefied, but always tends to return to its original volume (like a pile of springy shavings, he explains). If a vacuum is forcibly created by suction, water will even rise upwards to fill it, so that if a candle is burned in an enclosed vessel over water, the water-level will rise to replace the air destroyed by the fire.

Here, yet again, one is driven to admire the clear observation and reasoning of these Hellenistic scientists. Hero's lucid atomic theory is utterly reasonable and not far from modern theory. He uses it to explain siphons, pumps and all the many delightful tableaux in his *Pneumatics.*

But among these lighthearted toys there is a surprise: Between a trumpet sounded by compressed air and a novel water tap, we find the first "steam engine." It is a reaction-turbine driven by steam admitted through one axle. Of course there was no question of scaling it up. The technical difficulties would have been insuperable even if Hero or his masters had seen the unimaginable potential in this one toy among many, and it remained nothing more than an ingenious demonstration of a fundamental principle.

Even so, the 100 megawatt monsters which are providing your light and power at this moment, have as their ultimate ancestor a globe put together by some craftsman-slave in the Museum at Alexandria.

For all its brilliance, the Museum was a relatively small department of the cultural institution. Most of the learned men supported by the Ptolemaic dynasty were poets and literary scholars in the arts faculty, the great Alexandrian Library.

The Ptolemies supported their library as something of a creative hothouse. Poets and epigrammatists flourished and competed in regular official literary competitions. But, unlike their more easily institutionalized scientific colleagues, the many state writers and dramatists largely failed to surpass the achievements of classical Greece a few centuries before. One critic, Timon of Phlius, commented scathingly:

"In the thronging land of Egypt,
There are many that are feeding,
Many scribblers on Papyrus
Ever ceaselessly contending
In the bird cage of the Muses."

Of great importance for us was the solider work of the textual critics, impelled by the steady increase in the Library's collection. This the Ptolemies vigorously expanded by purchase, persuasion and fraud, seeking to possess a copy of every book in the world.

Ptolemy III did not hesitate to abandon large sureties rather than return "borrowed" state editions of Athenian masterpieces and confiscated all books arriving in Alexandria. (He had cheap copies made to return to the hapless owners.) These tactics so swelled the Library that a second storehouse was needed, and this was founded in the temple of Serapis who was a Greco-Egyptian god fostered by the Ptolemies in order to unite the religious aspirations of their Greek and Egyptian subjects.

To catalog and classify the books as they came in was a big enough job by itself; but the Library scholars set themselves the far harder task of ensuring the authenticity of their collection, to exclude corrupt texts and guard against debasement of the fine Greek language. These Alexandrian scholars laid a firm foundation for all later knowledge of classical Greek artistic and historical tradition, and the debt of gratitude we owe them is incalculable. For we are linked to the distant past chiefly by a tenuous thread of words. The very saga of Ptolemy and his Museum and Library itself can only be pieced together from a host of incomplete and contradictory sources, so that there is scarcely a detail in my story so secure that all scholars agree on it or that no future archaeological find could modify it. The whole patchwork history of Mankind survives only through the irredeemable, unguessable chances that decide that one man will write and an-

other will preserve. And but for the Library's scholars, scouring the world for books, copying, preserving, restoring and distributing them, the great bulk of Greek literature would almost certainly have perished.

A book in Alexandrian times was not like this magazine. It was a long roll of papyrus, made from Nile plants of the same name and was inscribed by hand. Such things were clumsy to store and handle, and a single work could use many of them. Furthermore, except under very dry conditions, papyrus may last less than a century or two. Vellum, made of animal skin, was more expensive than papyrus, but was more durable. A work deemed of sufficient worth to merit vellum was far more likely to survive.

The art of writing, too, was surprisingly crude. Many variant texts existed of the same original work, and there was no punctuation. Letters followed one another without a break, the smallest subdivision being the paragraph! Since Greek grammar depends crucially on word-endings, multiple ambiguities were common. The Alexandrian scholars, intent on preserving the classics and the elegance of their language, had by themselves to invent the art of editing and to discover Greek grammar.

It seems strange to think of discovering grammar, but just as most people today speak instinctively without realizing the rules they are obeying—or disobeying—so did the early Greeks. The grammar of your own language is as much a discovery as the anatomy of your own body.

Many scholars dedicated themselves to this work, but perhaps the most notable are Aristophanes of Byzantium and Aristarchus of Samothrace. Aristophanes, librarian from 195-180 B.C., is credited by some with inventing rudimentary punctuation. How curious it seems that this simple idea, putting gaps between words and using extra signs to denote literary intention, had to be invented! Yet Aristophanes' reforms were only slowly adopted, and it took the introduction of printing in the 1500s really to stabilize written language. Aristophanes edited many classical texts, such as those of the playwright Aeschylus, comparing different versions and reconstructing the most authentic one. Aristarchus, librarian from 160-145, continued this work, and it is claimed that his output of commentaries and critical treatises filled 800 rolls.

The "Alexandrian recensions" of Greek texts, as they are called, all carefully edited, published with the authority of the Library of Alexandria behind them, and circulated throughout the ancient world, are the original sources for virtually all later copies. Our knowledge of the masterpieces of Homer, Euripides, Sophocles and the other masters depends totally on the skill of the Alexandrian scholars, who had to invent the tools of literary criticism for themselves.

Aristarchus fled the library in 145 B.C.; he is the last known librarian but for a soldier, mentioned in a papyrus as "Cydas of the bodyguard." To understand this ominous development, we must understand the turbulent politics of Alexandria.

The beginning of the end

Even the favored servants of absolute rulers are in potential danger, and from the early days of the Museum the noble ideals of the Ptolemies were subject to political considerations. Even Ptolemy II banished Demetrius of Phalerum whose advice had helped to shape the Museum; but he still encouraged and took part in its free working.

Later Ptolemies must have been distinctly disquieting employers; Ptolemy III employed an official flatterer, and Eratosthenes rather fawning dedication of a geometrical problem to him contrasts strongly with Euclid's forthright assertion to Ptolemy I that there was no "royal road" to geometry. Finally, during the reign of the ruthless Ptolemy VII (145-116 B.C.) the native Egyptians in Alexandria revolted and were put down by military force. The Museum was closed down, scholars fled. Later the Museum opened again; but the safe haven for bold speculation was gone for good, and science and learning flourished thereafter in an increasingly hostile atmosphere.

Next month: Triumph and destruction

In the Museum's sister institution, the Library, literary scholars discovered Greek grammar and the art of editing, while preserving on papyrus scrolls our heritage of Greek literature.

Spilhaus tinkers with his "space clock," which times the moon, the tides and the stars all at once.

By Jane Stein

A technologist's technologist

Athelstan Spilhaus, eccentric, optimist and a flywheel in the machine of American science, believes we can solve our problems

In an office in the Smithsonian's 19th-century Castle tower a controversial member of the American science establishment is thinking about the 21st century, talking about experimental cities and writing a syndicated comic strip. Named after an ancestor who ruled Cornwall in A.D. 800, he is Athelstan Spilhaus, meteorologist, oceanographer, environmentalist and superspokesman for science and technology.

Formerly president and now chairman of the American Association for the Advancement of Science, Spilhaus is presently a fellow at the Woodrow Wilson International Center for Scholars. The Center was established by Congress in 1968 as a living national memorial to the 28th President and is designed to bridge the world of learning and the world of public affairs through programs on major contemporary policy issues.

Benjamin Read, director of the Center, stresses Spilhaus' high idea quotient: "He has ideas on the widest gamut of topics and he isn't afraid to give any of them." Some of them are outlandish—such as building ice dams which can be melted when they silt up, or embellishing the scenery of the Midwest with a mountain of junked cars. "Practicability isn't the be-all and end-all of ideas," says Spilhaus with heavy traces of his native South African accent. "What is important is getting out of patterned, traditional ways of thinking. I don't want to do anyone's thinking for them but I do want to incite and intrigue them." Why, he asks, must we continue to build things that last into periods when they are obsolete? Why not make demountable buildings from reusable materials?

We are not consumers, says Spilhaus, but temporary users of materials. We convert the resources of the Earth for our use and we must reconvert them for future use. Automobiles, for example, should be built with their ultimate reclamation designed into them. We are also wasteful of power; we should design things so that they don't require so much. We inquire about the miles-per-gallon we get from a car, but we never ask how much wattage a toaster uses.

For years, Spilhaus has worked within the "system" acting as the establishment's Jiminy Cricket, and using the system to startle and sometimes to dismay. He calls himself "an innovator for living" and his gospel is that something can be done, we are not doomed. Spreading the gospel since coming to the Woodrow Wilson Center earlier this year, he has traveled to Taiwan and Korea to discuss local environmental problems and their solutions with government and scientific leaders there. He has lectured across the United States on waste management, methods of pollution control and how to harmonize industry and nature. He has written articles on his ideas for future cities and our next industrial revolution, which he depicts as the building of a mirror image of our present industrial complex in the business of recycling the masses of materials we now produce.

Spilhaus isn't interested in promoting the details of his ideas. "By the time my ideas are acceptable, I am usually onto something else, and I'm not good at looking backwards," he says, adding that this is why he finds it difficult to write books—they are a rehashing of ideas. Magazine articles, he maintains, can reflect current thought—and so can comics. Since 1958, Spilhaus' scientific comic strip, *Our New Age,* has appeared in some 110 Sunday newspapers here and abroad. When he embarked on his career in comics—he writes them and cartoonist Gene Fawcett does the drawing—Spilhaus was dean of the University of Minnesota's Institute of Technology. To colleagues who did not think it was a dignified occupation for a dean, he would reply, "Which of you has a class of five million every Sunday morning?" *Our New Age* is a precise reflection of what Spilhaus is involved with at the moment. Earlier comics dealt with the sea, as did he. There were items on drugs from the sea, ocean mining, undersea vehicles. Recent comics have dealt with the environment: reusing metals from cars, noise pollution, energy demands, recycling.

For Spilhaus the strip is a hobby, an interesting

A Washington-based free-lance reporter, Jane Stein wrote about thermal pollution created by power plants in the June issue of SMITHSONIAN.

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exercise in brevity: In 150 to 170 words he has to explain a concept. "It makes me condense my thoughts and use small words, and it is a way to get ideas across to the public. But," he adds, "it makes me immoral on planes. I tear sheets out of magazines for my files."

Another hobby for Spilhaus is inventions and, like the comic strip, they too arise logically from whatever his current interest may be. For example, the Spilhaus Space Clock—a machine that tells many different times—began when he was doing oceanographic work at Woods Hole, Massachusetts. His five children had difficulty assembling for dinner since everyone was out sailing at high tide or digging clams at low tide. Why be bound by sun time, reasoned Spilhaus, when tide time fits the needs of our family better? So he built a clock that told tide time and the family ate together at half-tide.

Such was the beginning of the space clock (p. 62) which tells the time in major cities of the world, sidereal time (based on the sidereal day—23 hours, 56 minutes, 4.09 seconds), gives the sun's position and the time of sunset, the time of moonrise and moonset, the moon's position and phase, the times of high and low tides at any coast, the current stage of the tide, the current position of the stars over any position on Earth, and the day and the month of the year.

Behind the comics and the inventions, behind his lectures and innovative suggestions, lies an unflagging faith in science and technology, if, as Spilhaus adds, "they are properly used. I am interested in seeing how science can be harnessed for good purposes."

While he admits to being an incurable optimist, he sincerely believes that science and technology are the only muscles we have to clean up the mess that science and technology produced. Many other scientists and environmentalists disagree with this technology-oriented approach, and berate him for neglecting other solutions to problems, such as legal or economic restraints on polluters.

Last year, with his deep loyalty to the system, Spilhaus became embroiled in a controversy in the scientific establishment. Atomic Energy Commission Chairman Glenn T. Seaborg was nominated to succeed Spilhaus as president of the American Association for the Advancement of Science. Seaborg's nomination aroused the ire of many members who felt that the AEC is identified with pollution, atomic bombs and promoting nuclear power plants—all of which might create a conflict between Seaborg's role as AEC chairman and AAAS president. Spilhaus, the technologist's technologist, supported the nominating committee's right to nominate and urged Seaborg not to withdraw; he ultimately won the election and later retired as AEC chief. "It turned out to be a tempest in a teapot," says Spilhaus, dismissing the year-old controversy that had caused a split between AAAS members, even to the extent of a staff resignation.

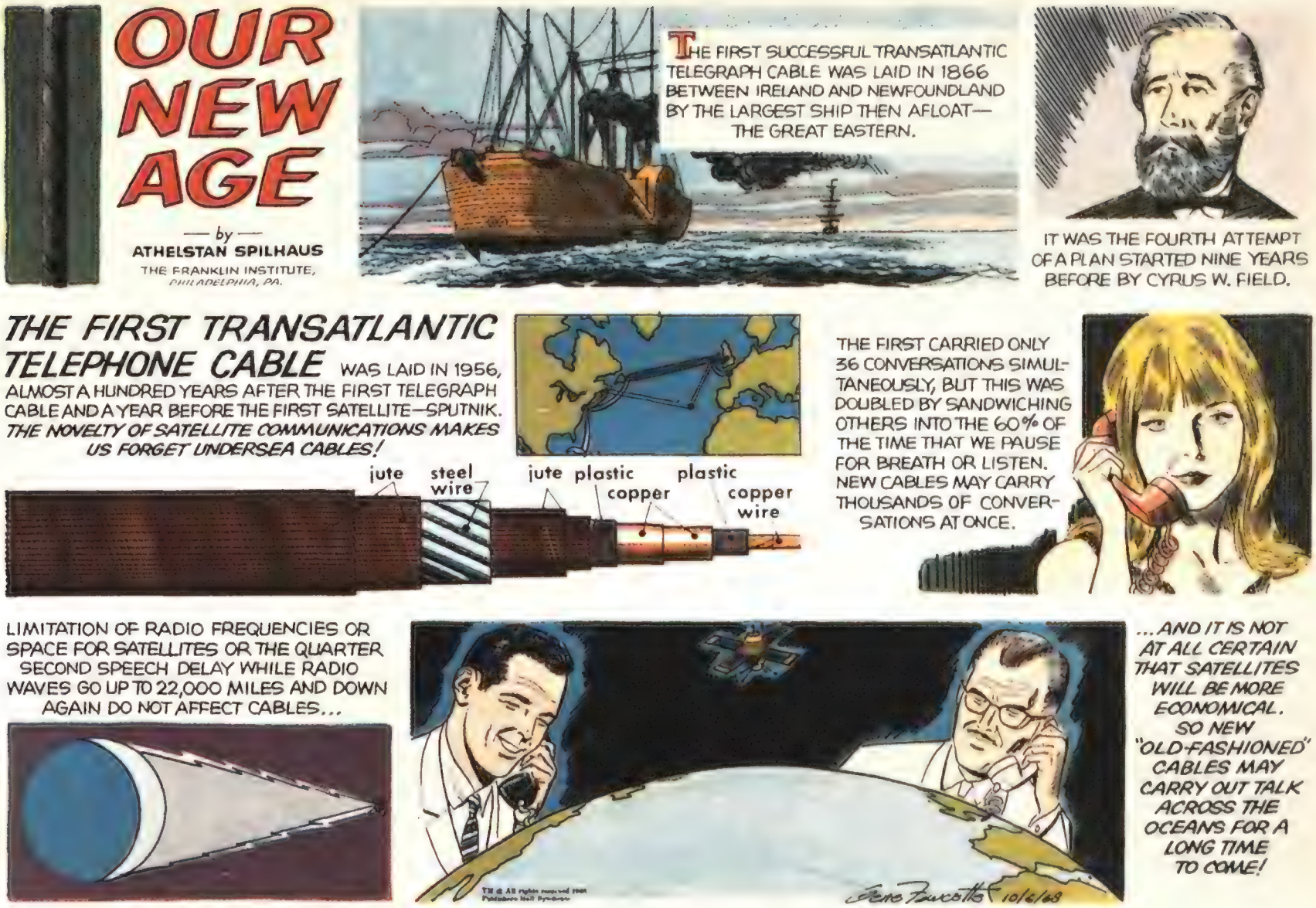
But Spilhaus is undaunted by the past. "I am always thinking about the future. I love finding something I don't know how to do and then damn well doing it. If I didn't do so many things, I would miss up on the great interrelationship of things." The word Spilhaus uses repeatedly to describe the world is synergism—the interrelated actions of many parts that combine to make something far greater than the parts themselves. And synergism describes the way he sees his own multidimensioned career.

From the atmosphere to the oceans

Forty years ago, after studying mechanical engineering at the University of Cape Town with summers as an apprentice engineer aboard ships that took him to Asia and Europe, his wanderings brought him to the United States. At MIT he did research on aeronautical and meteorological instruments, then returned to South Africa and started the first upper-air meteorological investigations in the Southern Hemisphere.

Back in this country in the mid-thirties, Spilhaus put his love of sea to work. His move from meteorology to oceanography was a natural one—"synergistically" related. Both meteorology and oceanography relate to fluids and both are interdependent, he explains. You can't understand the atmosphere without understanding the oceans, which give the surrounding air its energy; and you can't really understand the oceans without understanding meteorology—how the winds raise waves and drive the surface currents.

Spilhaus joined the Woods Hole Oceanographic Institution and, at the age of 26, made his first big invention and his greatest single technical contribution to the science of oceanography: an instrument called


OUR NEW AGE
— by —
ATHELSTAN SPILHAUS
THE FRANKLIN INSTITUTE, PHILADELPHIA, PA.
THE FIRST SUCCESSFUL TRANSATLANTIC TELEGRAPH CABLE WAS LAID IN 1866 BETWEEN IRELAND AND NEWFOUNDLAND BY THE LARGEST SHIP THEN AFLOAT— THE GREAT EASTERN.
IT WAS THE FOURTH ATTEMPT OF A PLAN STARTED NINE YEARS BEFORE BY CYRUS W. FIELD.
THE FIRST TRANSATLANTIC TELEPHONE CABLE WAS LAID IN 1956, ALMOST A HUNDRED YEARS AFTER THE FIRST TELEGRAPH CABLE AND A YEAR BEFORE THE FIRST SATELLITE—SPUTNIK.
THE NOVELTY OF SATELLITE COMMUNICATIONS MAKES US FORGET UNDERSEA CABLES!
jute
steel wire
jute
plastic
copper
plastic
copper wire
THE FIRST CARRIED ONLY 36 CONVERSATIONS SIMULTANEOUSLY, BUT THIS WAS DOUBLED BY SANDWICHING OTHERS INTO THE 60% OF THE TIME THAT WE PAUSE FOR BREATH OR LISTEN. NEW CABLES MAY CARRY THOUSANDS OF CONVERSATIONS AT ONCE.
LIMITATION OF RADIO FREQUENCIES OR SPACE FOR SATELLITES OR THE QUARTER SECOND SPEECH DELAY WHILE RADIO WAVES GO UP TO 22,000 MILES AND DOWN AGAIN DO NOT AFFECT CABLES...
...AND IT IS NOT AT ALL CERTAIN THAT SATELLITES WILL BE MORE ECONOMICAL. SO NEW "OLD-FASHIONED" CABLES MAY CARRY OUT TALK ACROSS THE OCEANS FOR A LONG TIME TO COME!
10/6/68

Spilhaus' weekly comic strip, thought by some an undignified avocation, is read by five million.

a bathythermograph, a temperature-depth gauge.

He was seeking to invent a device that could make a precise continuous record of temperatures against pressure or depth, and help biologists, oceanographers and fishermen to find the temperature distribution in the surface layers of the sea, called thermoclines. These natural boundaries between warm and cold water are where fish often congregate and where submarines like to take cover. The usual way of detecting prenuclear submarines was by tracking their sounds with special instruments, but sound passing through water in a thermocline is bent, which makes submarines difficult to detect.

Spilhaus used the principle of a meteorograph, an instrument that measures temperature against pressure in the upper air, and devised a way to use it in the different conditions of the sea. The first successful test of the bathythermograph was in 1937, and when World War II broke out they were put into mass production and used in anti-submarine warfare.

Later, serving in the Air Force as a meteorological expert, he slipped into northern China and settled in Yenan where he lived in a cave, taught the Chinese guerrillas to set up weather stations behind Japanese lines and radioed the weather information to the U.S. troops in the Pacific. In Yenan he met Chou En-lai and Mao Tse-tung, and was occasionally a guest at dinners that featured delicacies such as duck's eyes, chicken's feet, old eggs, cock's combs. Spilhaus—a man who enjoys both eating and cooking—recalls that he ate everything, proceeding on the theory that these things had been eaten with great relish by the Chinese for centuries. Why shouldn't they be good?

Immediately after the war he returned to the upper atmosphere, and became chairman of NYU's Department of Meteorology. In 1947 he went to South Africa to reorganize the government's meteorological services and to complete a Doctorate of Science at the University of Cape Town.

Returning to the United States he became the dean of Minnesota's Institute of Technology. While there he got the idea for, and helped establish, the sea-grant college program.

Spilhaus uses this as one of the many examples in his life of how one thing led to another. He recalls: "The idea of sea-grant colleges just came up naturally,

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since I was dean at a land-grant college," (a school originally financed by grants of land given to them by the federal government). In 1963 he proposed that sea-grant colleges be established to pull the science of oceanography out of the research laboratories and apply it to the practical exploitation of the ocean. The result: a National Sea Grant Program now set up within the Department of Commerce enabling colleges to offer programs in ocean engineering, aquaculture and marine pollution. Since 1968, 75 colleges and institutes have received nearly $33 million worth of sea grants.

The jump from Spilhaus the oceanographer to Spilhaus the environmentalist might seem incongruous, but of course he sees it as a highly logical transition.

He recalls that about ten years ago while he was chairman of a National Academy of Sciences (NAS) committee on oceanography, the Atomic Energy Commission sought NAS advice on the dumping of radioactive wastes in the sea. One idea was to pick an area in the ocean where there is heavy sedimentation and bury them there in canisters.

"At that point," admits Spilhaus, "I wasn't terribly aware of environmental problems. But I did begin to think that some of these radioactive wastes that might be dumped into the oceans have half-lives of hundreds of thousands of years, and that we might be mining sea sediments way before that. In this way, I became very much interested in problems of waste."

While serving on another NAS committee on natural resources, he bulldozed the problems of waste into the discussions. Trying to assess how much iron the United States has, he asked the question: How much iron rusts yearly? It was at this point that he began thinking about waste as a natural resource: By curbing wastes we would be increasing our natural resources. ("Waste," Spilhaus likes to say, "is some useful substance that we haven't the wit to use.")

The next step in the environmental education of Athelstan Spilhaus was on still another NAS committee that he chaired, on pollution. The final report called for massive studies in new waste-management techniques, including building an experimental full-scale system in a new city.

And there he was—and is—involved in problems of new cities.

In his office—with his many different projects neatly piled in different drawers, on bookshelves and tables—Spilhaus says he is working on the problems that "preoccupy people today centering around runaway population, disaster conditions in the cities, deteriorating environment, the multiplication of things that we use, exhaustion of resources and ever-growing per capita energy consumption."

"Most people only work on one or another part of this," he says, "but they are all part of the same system, and are symptoms of the population problem. In a generalistic way, I am trying to put them all together."

Experimenting with cities

Spilhaus' experimental cities would be mass-produced. Walls, for example, might be made of a sandwich of materials, with telephone wires, television lines, water pipes, electricity conduits already built into them, rolling off a mill in a continuous sheet, sliced into modular sizes for assembly.

His cities would include new ways of moving people such as pneumatically or electrically driven "private people pods" that pass noiselessly through buildings. They would have novel systems to manage solid wastes and to control pollution, using the same underground transportation conduits that bring in things like food to take out residues to recycling plants on the periphery of the city. Services would be put in the basement of the city and the population wouldn't be allowed to grow beyond that number for which the services were designed.

The actual costs of building one experimental city for 250,000, he calculates, is almost what it costs to run our space program for one year. "I think that space research is terribly important, but," he adds, "I think it's at least as urgent to solve our problems on Earth."

And does this perennial optimist see these cities being built? Yes, but in gradual steps, not with one massive building project. He sees his plans for experimental cities as a way of putting concepts into peoples' minds, concepts which engineers and city planners will then weave into their own designs, just as his inventions are engineered by others. And by the time one experimental city is complete, Athelstan Spilhaus will probably have moved on to a new project.

A pensive Spilhaus absently fingers a windup spring mechanism, reflecting on the experimental cities which he sees clearly in his mind's eye.

By Jan Reese

Doomed island and a lament

An osprey expert and experienced bird watcher decries the natural death by erosion of Poplar Island in Chesapeake Bay

A young osprey, eyed by its nesting parent, alights on a broken wreck in the shoals of Poplar Island.

For eight years I have watched ospreys occupy an island that may not be there in eight more.

One pair used to nest in a dead tree snag near the wreck of a fishing boat. In the winter of 1966 the snag disappeared into Chesapeake Bay, and the nest with it, so I built a platform above the reach of summer tides on the rotting *Arabelle's* bow. Twelve days later it held a nest with two brown-and-white eggs. All was well in 1967, but the next year I returned to find the platform collapsed. The same ospreys greeted me with shrieks and withdrew to a nearby tree while I hammered together a new platform. Three hours later one bird was breast deep in sticks while the mate brought more from shore. The next year I had to remove the nest; the birds screamed at this sacrilege but resumed homemaking when I had repaired the platform and replaced the nest. In 1970 the ospreys were on hand when I arrived; again winter had destroyed the scaffold. As I reconstructed it, the silence from their treetop perch was broken only by an occasional call. The ospreys watched intently, then burst into a screaming chorus as I finished. They went to work building a new nest before I'd gathered up my tools.

Next spring the platform may be gone again, perhaps even the *Arabelle's* hulk—victim of the Chesapeake's tireless tides and storms. Why? Because the bay is devouring Poplar Island and Man has not stayed the hungry erosion. I have done what I can to help the birds, but the Chesapeake is winning, eroding the windward shoreline 14 feet a year in places. Wild animals and birds are not alone in being threatened with extinction; here, two-and-a-half miles off Maryland's Eastern Shore, part of the earth itself is vanishing, vanquished by the tides, tempest and human indifference.

Reese studied the subject islands under the aegis of the Smithsonian and the Interior Department.

Once a single island, the place comprised more than a thousand acres when Captain John Smith first sighted it in 1608. For three centuries it supported watermen and farmers. Today it has been battered into several islets—owned in large part by the Smithsonian Institution—totaling no more than 163 acres. The timid tenants, wild breeding colonies of osprey and great blue heron, will be hard pressed to find new nesting sites in the densely developed bay region if this sanctuary disappears, as it easily may.

Formerly a horseshoe of land open to the east, the

By David Challinor

But islands too are only clay

A Smithsonian scientist discusses Man's license or ability to intervene here and weighs the alternative of studying nature taking its course

There are tides in the affairs of nature that Man frequently tries to stem—usually for his own purposes, especially in the name of "progress," and sometimes for altruistic reasons. The Poplar Islands dilemma, if resolved to favor a *status quo ante,* will exemplify the latter, that is, well-meaning human intervention in a natural process.

Millennia ago these islands constituted a single landmass of some 2,000 acres; then they began to erode. Without artificial rebuilding they will disappear as inevitably as every biological organism, or even as mountains do in the course of eons. It is easy to argue that the islands must be rescued, if only as some sort of ransom against human plunder elsewhere in the world. But a germane question remains: By what right (or to what purpose) should Man seek to mitigate a process as inexorable as the wearing down of the once tall Appalachians, or the extinction of the woolly mammoth, or the demise of some other species doomed by nature?

Chesapeake Bay, a comparatively young estuary, was evidently formed about 8,000 years ago and will probably disappear in a like time. It was largely created by erosion, from the runoff of melting glaciers; and the companion process of siltation will probably fill it until a river meanders through Maryland to a delta near Norfolk, Virginia. The process is a viable one and largely immutable by Man—thus far. Several islands of recent memory are gone, eroded and become silt. Parts of the Eastern Shore have lost two-thirds of an acre per mile *annually* for more than a century.

There are several reasons—environmental, economic

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Dr. Challinor, a concerned conservationist, is the Institution's assistant secretary for science.

island had long since been cut by wide channels into three separate islands totaling more than 200 acres: Coaches Island to the southeast, Jefferson to the northeast and, to the west, Poplar Island proper (according to modern nomenclature). Over the next 20 years this windward land dwindled to a narrow wooded strip that winter storms chopped into four smaller pieces. The total land area of Poplar Island proper shrank to less than 100 acres. It now comprises barely 54.

On my first exploration in 1963, masses of poison ivy grew to 15 feet, reducing air circulation and inten-

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Reese, continued from page 69
sifying the June heat. Hundreds of herons, nesting in the 40-foot loblolly pines year after year, had covered the vines below with their droppings. Biting flies made my life miserable and snakes slithered through the snarl of fallen trees and vines. Kingbirds, crested flycatchers and house wrens were abundant, as were spiders, robber flies, dragonflies and five-lined skinks.

At scattered locations, too, I found the vine-covered remnants of past human habitation. Vast beds of flowering lilies, a razed building, broken foundations, an orchard, piles of bricks and bottles, great heaps of oyster shells, stump-cleared alleyways where roads and lanes once ran through the trees, a graveyard.

Poplar Island has known many owners and many names. John Smith called it one of the Winstones. In 1631 Captain William Claiborne, a Virginia Puritan who established a trading post on nearby Kent Island, became the first white man to visit and claim it. According to most Talbot County histories he named it Poplin's Island for an associate. One of his followers, Richard Thompson, settled his family there; a few years later Nanticoke Indians massacred the household while he was away.

By 1654 the name had been corrupted to Popeley's and a former Maryland governor had sold it for 10,000 pounds of tobacco to one Thomas Hawkins. He sold half to Seth Foster and deeded the other half to his wife Elizabeth and his son. Hawkins died and Elizabeth married Foster. "Foster Island" became a sanctuary for Alexander D'Hynoisa, Dutch governor of what was to become Delaware.

Bootleggers and presidents

When Charles II captured the Dutch colonies in North America, D'Hynoisa received asylum on the island from Lord Baltimore. The Dutchman then bought it from Foster for 300 pounds sterling in 1699 and lived there as a naturalized citizen. Early in the 18th century the place became the property of the father of the famous Charles Carroll of Carrollton, a signer of the Declaration of Independence and one of the richest men in America. By that time Popeley's had been further corrupted to Poplar.

In the 19th and early 20th centuries, Poplar Island supported a thriving little community peopled chiefly by watermen who made their living from oysters, fish and crabs. It had several small farms, a school, general store and mail service—weather permitting. Harvests of grain and seafood were shipped north to Annapolis, Baltimore and other ports in barges and skipjacks, the sloops unique to Chesapeake waters.

Each year, however, existence grew more difficult as the hungry bay claimed more land through erosion.

Gulls clutter the early morning sky over the shallows, a heron flies from fishing and an osprey waits.

The acreage, given as 806 in 1847, was down to about 500 in 1912 and 485 a few years later. In the mid-1920s the remaining inhabitants gave up and moved away.

Though the island was fragmenting, it was not completely abandoned. In 1929 federal agents determined that suspicious characters were frequenting the place; the revenuers made a visit, captured five bootleggers, and broke up a 1,000-gallon still. Two years later, a group of influential Washington Democrats acquired the small, deserted northeast island which they renamed Jefferson. They built a spacious lodge and established the exclusive Jefferson Islands Club. In the heyday of the New Deal, President Franklin D. Roosevelt was a visitor, eating Maryland oysters, crabs, wild duck and terrapin.

President Truman also enjoyed the club, but by 1950 the lodge had burned and the members disbanded. They sold out to executives of a Delaware corporation who built a new clubhouse as a base for goose and duck shooting. This clubhouse also burned.

The most recent man-made venture—and perhaps the last—was an attempt by an individual to establish a yacht club in 1960. After building a third clubhouse, he sold the islands to Dr. William L. Elkins of Philadelphia for a summer retreat. In 1966, Dr. Elkins began deeding the islands to the Smithsonian in the hope that measures might be taken to halt the erosion and save the birds. The lodge and its outbuildings on Jefferson Island are now used as shelter for visiting scientists and as the caretaker's home.

Today, erosion remains Poplar Island's most savage enemy. No shoring or bulkheading has been attempted

on the western shore. Timber enough to build a small house rumbles into the bay annually. Along with the trees go the nests of a few more great blue herons.

In 1964, I started driving stakes and marking trees at various exposed locations to measure annual erosion. Of ten sites marked, three have averaged inland losses of 14 feet a year and all have lost more than two feet annually. Worst of all, new wash-throughs occur almost every winter; the pace of erosion is increasing.

If nothing is done, it is only a matter of time until Poplar Island proper dissolves into a series of tiny, barren hummocks. At the present rate, it probably will be denuded of trees within a decade. When that happens, little Jefferson Island, now partly sheltered by Poplar, will be at the mercy of the bay's winds, waves and currents. (Coaches Island, most shoreward and southerly of the three, already is eroding steadily, though at a somewhat slower pace than Poplar.)

What then becomes of the ospreys and the great blue herons? If their future is not something with which we human beings are concerned, it should be. For the Poplar Island colonies of these two species are among the finest remaining in America.

Some 30 pairs of ospreys nest annually here and in the immediately adjacent waters. This is the largest osprey concentration in so small a space on Chesapeake Bay, and it is part of an even larger community in and around Talbot County that constitutes the most successful osprey colony north of Florida.

Or would it be more accurate to say "least unsuccessful" in this context? Talbot County's ospreys are not being wiped out as they are in New England and the Great Lakes region, where the once-large populations have been reduced to a few individuals or obliterated by chemical pesticides and the destruction of breeding sites. But neither are they doing more than, at best, holding their own. My annual studies of osprey breeding in the Talbot County area since 1963 show a slight decline in the number of fledglings produced per nest during the period. Although the success rate remains substantially above those of most other well-documented U.S. bird populations, it is less than half that of Chesapeake Bay ospreys before 1947, when hard pesticides such as DDT were introduced.

As for the Poplar Island birds, their future is uncertain. Their reproduction rate seems to have been impaired by chlorinated hydrocarbons which they absorb from live fish, their chief food. Their nests and young are subject to human depredations, some innocent, some deliberate, which wipe out a disgraceful number of eggs and hatchlings each year.

These range from picnicking pleasure boaters, whose mere presence keeps the adult bird off the nest (while the sun cooks eggs or young), to Coast Guard personnel who often must destroy nests on lighted navigation markers. Most important, their island is dying. My artificial platforms cannot offset this erosion. Poplar Island's sheltering landmass, however diminished, provides snags and dead trees for nesting sites, building material and protection against storms.

Threatened herons

Poplar Island's other magnificent breeding birds, the great blue herons, face an even more immediate threat Here in one of the largest heron colonies on the eastern seaboard, I estimated nearly 500 active nests in 1963; in 1971, about 120.

Like the osprey, the great blue heron is a fish eater and so is endangered by the persistent pesticides it absorbs. More important, the great blue heron—even more than the osprey—must have an isolated, undisturbed breeding site to survive. Herons build huge, untidy nests of sticks in the branches and high forks of trees; they stay as far away as possible from human habitation. Shy and wary creatures, they flush from the nest at the slightest disturbance, exposing eggs and nestlings to predators and the sun. If frequently disturbed, they abandon the nest. And they cannot be induced to adapt themselves to a man-made platform.

On Poplar Island the great blues nest in the branches of the loblolly pines that cluster along the eroding western shore, congregating in late March and early April to lay four or five blue eggs and brood their young. Some stay all year, roosting in the loblollies by night and fishing in the shallow waters by day. To see one of these great slate-blue birds, more than three

Reese, continued

feet tall, towering above its nest like a giant sentinel outlined against the sky, is to recapture a vision of an earlier and more beautiful America.

Already their nesting trees are being washed away—as many as 40 a year. Many displaced birds seek breeding sites elsewhere. When the island is gone, the sad prospect is that the herons—at least in anything like their present numbers—will be gone from the bay also. So too, the hundreds of swans, geese, ducks, grebes and loons that winter each year in the island's lee.

I believe Poplar Island can be saved, but it will cost a good deal of money. High-sounding talk, the only weapon applied so far, certainly won't stop the tireless Chesapeake. Last winter a state survey was finally made that estimated the minimum cost of erosion control on the windward shore of Poplar Island to be about $800,000.

Unfortunately but predictably, Maryland is not primarily concerned with the fate of the herons and ospreys. The Department of Chesapeake Bay Affairs' mandate was to consider how "to develop shore recreational facilities for the benefit of the boating public." One plan reportedly called for the state to take title of the entire island group, lease part of it back to the Smithsonian for wildlife studies, and establish a boating center on Jefferson Island. The state would pay for erosion control.

Disaster for the birds

This might be nice for the boating public, but it would be disastrous for the birds. If the island group is turned into a playground for people, there will be little wildlife for the Smithsonian or anyone else to study. Boaters, campers and picnickers would drive away the nesting colonies as surely—and a lot more quickly—than continued erosion.

But can the legislature be convinced that a chunk of land is worth saving without regard to its dollars-and-cents value to Maryland voters? Or that funds should be voted to benefit a few birds? This is a difficult concept for most Americans to grasp.

I have lived within sight of this jewel in the Chesapeake all my life, have known it intimately for the past eight years. I have watched it blossom in the spring, listened to the eerie clicking voices of hundreds of incubating herons, marked the joyous growth of new, young living creatures through the summer. I have watched them mature and have seen the islands dormant in the harsh blast of winter. I, for one, will mourn this island if it dies. But it will be equally tragic if the island ends its long and stubborn battle against the Chesapeake as a piece of kept land, a parking place for Sunday speedboats.

Challinor, continued

and emotional—that at an easy glance justify strenuous efforts to save the islands. They protect part of Talbot County's eroding mainland from the full force of tides and waves. They provide a safe harbor for watermen and winter feeding grounds for thousands of waterfowl. They constitute esthetic and sentimental landfalls in the protean bay. A most important consideration is the plight of the ospreys and great blue herons. Could they survive without these nesting grounds? Would they relocate? They have done so before and we can assume they would again. They probably did not frequent Poplar when it supported a human community, but presumably nested in the loblolly pines only after men abandoned the dwindling land.

Is there a cogent argument for letting the islands die? Yes, the rationale of scientific study and discovery. Knowing these islands are victim to relentless processes of decay, we can use them as a natural laboratory for examining these mechanics against the time another island is threatened. Watching these islands give up their ghosts could provide copious and useful data.

In economic terms it is certainly easier to study the decline and death of the islands than it is to save them, an effort that might cost upwards of four million dollars. That price tag—for filling the breaches, widening the shoreline by 100 feet and building a protective revetment (after cutting some trees to provide access for heavy equipment!)—comes from the Corps of Engineers, the organization with perhaps the greatest experience in trying to bend natural forces to human design. In terms of the GNP or the federal budget, this might seem a paltry sum, but it is naive to argue that moot point. In terms of realistic alternatives, should the national government save these islands rather than cure urban blight?

Should Maryland spend tax revenues here that

might otherwise cleanse the polluted upper Chesapeake? Should the Smithsonian discontinue astrophysical research or abandon its Chesapeake Bay Center for Environmental Studies to preserve 54 acres of languishing island that have debatable scientific, human and ecological importance? It is all very well to hope that public money used for some ignoble cause be applied to island conservation, but the fact remains that funds once spent on biological warfare, for instance, probably won't be diverted to Chesapeake Bay this fiscal year, or next.

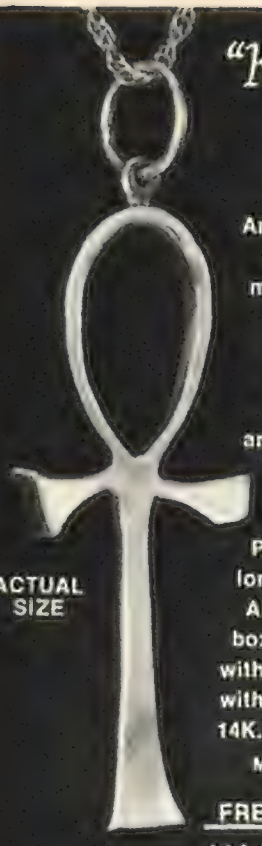
Priorities aside, the feasibility of preserving the islands without adverse side effects has not been proved. Some seemingly attractive solutions had to be abandoned after thorough study, such as using baled solid waste to protect the shoreline. (The bales themselves might erode, causing new pollution.)

The most promising proposal, from a professor of environmental engineering at the California Institute of Technology, involves a project twice as expensive as the Corps'—but one that would pay for itself. A rock breakwater would be built 1,000 feet to windward of the existing Poplar islets. Inert refuse would be dumped in the man-made lagoon to a level above high tide, covered with solid waste and topped off with a layer of sanitary landfill and soil, which would support new flora. The result: a larger, stabilized, fertile island. The project could be self-supporting since nearby Baltimore, for one, faces increasing difficulties in disposing of both its municipal waste and the demolition debris from buildings razed for urban renewal. Using Poplar Island as a carefully managed, selective dumping ground would be cheaper and cleaner than present disposal methods. (But such a practice must not become widespread, or the Chesapeake will be subject to such landfill pressures as San Francisco Bay.)

This last caveat points up why we must take such care; the solution to this dilemma must not cause worse ancillary problems. So the Caltech engineer's preliminary plan is now being reviewed by federal, state and private agencies prior to a final proposal.

If such a project is ecologically sound, technologically feasible and economically possible, almost all interested parties could accept the abandonment of a natural laboratory and the halting of a natural process. The sanctuary of these islands, which will *not* be converted to a marina at the expense of wildlife, will then be saved—nay, restored and expanded—for the perpetual use of birds that may remain there.

A soaring osprey hovers over Poplar Island (left). The stately heron guarding a treetop nest (right) is threatened by pesticides, pleasure boats and the tides.



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Smithsonian highlights

Television Special

"Getting There First—The American Experience," first in a series of TV film essays, will be seen in the first part of the new year on the American Broadcasting Company network. An MGM-GE television special, the script is written by Dr. Daniel J. Boorstin, director of the Museum of History and Technology (above climbing on a Southern Railway Pacific type locomotive in his museum).

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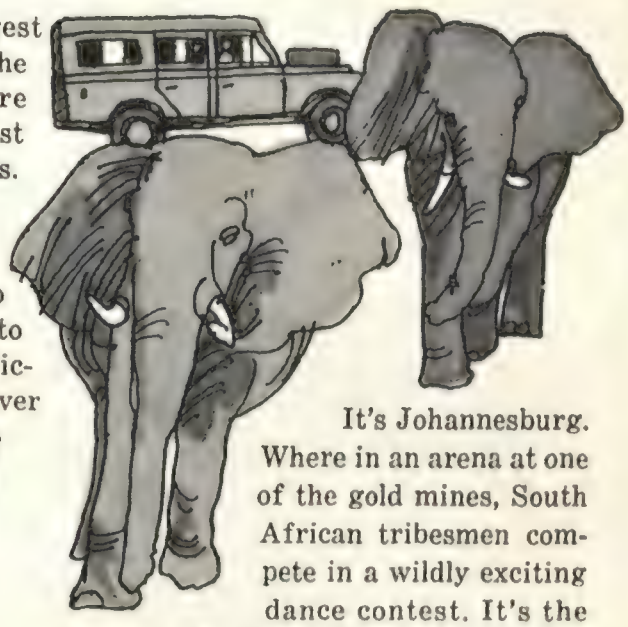
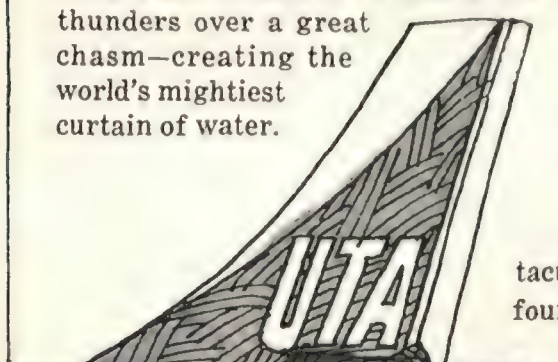


It's Treetops Lodge. Where from a comfortable vantage point you can watch elephant, buffalo, rhino and other wild game come by night to the water hole and salt licks. It's Victoria Falls. Where the Zambezi River thunders over a great chasm—creating the world's mightiest curtain of water.



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Tours for Associates

Study tours are designed as educational travel for members of the Smithsonian Associates. Smithsonian staff or other experts accompany all tours. For information, write offices listed below.

Foreign Study Tours—1972

For information: Miss Susan Kennedy, Room 123 SI, Smithsonian Institution, Washington, D.C. 20560.

Mexico and Guatemala: A visit to historic Yucatán, Oaxaca, Mexico City, Tikal and Antigua—April 3-21.
Australia and New Zealand: The tour will go out via Fiji and return via Tahiti with visits to Canberra, Australian Outback, Great Barrier Reef, Tasmania, Christchurch—March 24-April 27.
"No Tour" Tour: Dulles International Airport to Paris—May 29-June 19.
Greece and Yugoslavia: A classical tour of Greek archaeological sites with a visit to Yugoslavia's Adriatic coast and inland sites—June 12-July 10.
"No Tour" Tour: New York to Frankfurt—July 3-25.
King Arthur's England—July 11-August 1.
The Pilgrimage Road (France and Spain)—September 11-October 9.
"No Tour" Tour: Dulles International Airport to London—September 11-October 2.
Pakistan and Afghanistan—October 9-November 8.

Domestic Study Tours—1972

For information: Mrs. Patricia Kilkenny, Room 1208 A & I, Smithsonian Institution, Washington, D.C. 20560.

Sturbridge Village, Massachusetts: A Yankee winter weekend in the 18th-century atmosphere of this re-created village—January 21-23.
New Orleans, Louisiana: A study of its art, history and architecture—February 3-6.
Death Valley National Monument: A look at geology, climate, history in this desert region—April 14-20.
Navaho Land, Arizona, New Mexico, Utah: The past and present of the area will be explored—May 21-28.

Smithsonian Highlights

Continued from page 75

Associates Events
"The Christmas Story" an oratorio by Heinrich Schutz featuring instruments from the Smithsonian antique collection will be presented Monday, December 20 at 8:30 P.M. in the Museum of History and Technology. The program will be conducted by Joan Reinthaler with Helen Boatwright, soprano, John Urig, tenor and George Harshaw, bass. Works by Franz Tunder and Philipp Friedrich will also be included. Doors open at 8:00 P.M.

National Collection of Fine Arts
"John Steuart Curry (1897-1946)" presents a selective representation of 15 paintings and 20 drawings of the Midwestern regionalist.

"Discover Graphics '71" includes prints produced by Federal City College and D.C. high school students in the NCFA's print workshops. Begins December 11.

"Paintings and Prints of the 1930s" is a new and comprehensive collection and will be on display indefinitely.

"William H. Johnson (1902-1970)" includes 150 paintings, watercolors, drawings and prints in the first major museum exhibition accorded this black American artist. (See SMITHSONIAN, November 1971.)

"Thomas Eakins: His Photographic Works" presents some 200 photographs of or by this 19th-century American artist, including portrait photographs used for paintings and examples of the artist's outdoor work.

Division of Performing Arts
For ticket information on the following presentations, call 202-381-5395.

By popular demand "The Proposition" improvisational theater will return to turn audience suggestions on the political or social scene into short encounters or musical comedy, from December 2 to December 6 at 8:30 P.M. "Proposition Circus," a children's version will be held December 4 at 1:30 and 3:30 P.M.

"Eureka!" a fantasy based on discovery and invention will be presented by the Alan Stevens puppet company beginning December 15. An original show written especially for the Smithsonian will be performed daily, Wednesday through Friday. "Tom Sawyer" will be continued through December 5.

"Folk Concert," featuring Dave Bromberg, will be presented jointly by Performing Arts and the Folklore Society of Greater Washington on December 10 at 8:30 P.M. at the Museum of History and Technology. Seating will be arranged by reservation only.

Smithsonian Museum Shops
Christmas shops featuring gifts and ornaments from all over the world are open in the Museum of History and Technology and the Arts and Industries Building.

National Portrait Gallery
"Model Hall," once the largest room in the United States, used to display patent models until 1932, is now open to the public. Clara Barton and Walt Whitman nursed Civil War soldiers there and Abraham Lincoln received guests in the rotunda during his second inaugural ball. "The Monarch Prints," a collection of portrait prints of rulers important to the history of America, is on exhibit.

"Washington from Banneker to Douglass: 1790-1870" is an exhibition that includes portraits, photographs and documents presenting the black community's view of the history of Washington, D.C.

Dial-A-Museum 737-8811
In Washington, D.C., call this number for daily announcements on new exhibits and special events.

Museum of History and Technology
"Cast Iron and Tinplate Toys of Yesteryear (1880-1960)" includes a selection of toys from the Sears, Roebuck and Company American collection (see page 36).

"Early Electrical Appliances," an exhibit of old household items including toasters, irons, fans and eggbeaters, has opened in the Hall of Electricity.

"General Store Post Office" has been set up just as it was in Headsville, West Virginia, in the early 1860s and will operate as a post office with a postmaster in period costume stamping mail with Smithsonian postmark.

Arts and Industries Building
"Balloons" depicts the total history of balloons from how they were invented to future possibilities, covering forms, fabrics and functions.

Museum of Natural History
"A Century of Research and Science in Fisheries," an exhibit sponsored by the Departments of Commerce and Interior, commemorates the 1871 appointment of then Assistant Smithsonian Secretary Spencer F. Baird as the first U.S. Commissioner of Fish and Fisheries and covers the history of the conservation of fish.

Smithsonian Institution Press
Books on subjects ranging from history and art to anthropology and technology, plus records of Bach sonatas and American folk music are available at a 20 percent discount for Associates. For a complete list of current publications write: Publications Distribution, Smithsonian Institution Press, 1242 24th Street, N.W., Washington, D.C. 20037.

Freer Gallery of Art
"Eugene and Agnes E. Meyer Memorial Exhibition" includes mainly Chinese bronzes, jades, sculpture, paintings and ceramics. Many of the 32 objects have not previously been exhibited. An illustrated catalog is available.

Smithsonian Commons
Luncheon facilities for staff, resident scholars and all members of the Smithsonian Associates are located in the original Smithsonian Building. Open weekdays from 11:30 A.M. to 2:00 P.M., the Commons offers a buffet luncheon from $1.25 to $1.75 upon presentation of a membership card.

Traveling Exhibition Service
Over 70 Smithsonian-sponsored exhibitions open each month throughout the United States and Canada. For a complete listing write: Traveling Exhibition Service, Smithsonian Institution, Washington, D.C. 20560.

Terre Haute, Indiana—"Dutch Art Today" (Indiana State University, December 11-January 9).

Blacksburg, Virginia—"Norway Now" (Virginia Polytechnic Institute, December 18-January 16).

Urbana, Illinois—"Contemporary African Printmakers" (University of Illinois Library, December 4-January 2).

Clemson, South Carolina—"The Historic Architecture and Urban Design of Nantucket" (Clemson University, December 18-January 16).

Provo, Utah—"Mexican Folk Art" (Brigham Young University, December 11 to January 9).

Worcester, Massachusetts—"James Weldon Johnson" (Worcester Polytechnic Institute, December 4-January 2).

Anacostia Neighborhood Museum
"Accent '71," on exhibit this month, includes art work contributed by artists in the surrounding community, a children's "show me how" crafts area and a video tape presentation of the problems that beset Anacostia.

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Book reviews

The Night Country
Loren Eiseley
(Scribner's, $6.95)

This is the story of a man and of men. The man—Loren Eiseley, distinguished anthropologist and writer—is revealed through flashbacks to childhood and accounts of more recent experiences. Humans—all of us—are revealed through an expert's examination of our past, present and likely future in the vastness of evolutionary time. The tone is somber and somewhat mystical as the stories of the man and of men intertwine. Yet the effect is reassuring if for no other reason than that there certainly must be a meaning and purpose beyond the whim of pitiless nature for a species that can produce feelings and thoughts and writing such as this.

Through the book, like a black thread, runs the love-hate affair with the dark—the "night terror" he calls it—that Eiseley and all men have. As a child he explored sewers and tunnels with a mixture of dread and ecstasy, and as a man he has explored caves and another kind of darkness—that of misty past and elusive future and Man's lonely voyage through them. His confession, he says, "is that of a man with night fear, and it is also the confession of a very large proportion of the human race.

"In a way it is the fear of the tide, the night tide, I call it, because that is the way you come to feel it . . . and yet, as you grow older you realize that it is always there, swirling like vapor just beyond the edge of the lamp at evening and similarly out to the ends of the universe. Or at least it gives you that kind of sensation—a need to huddle in somewhere with a light."

Eiseley feels that Man is still on his journey, a dark and frightening journey towards an unimaginable destiny. Part of Eiseley's message is that this continuity puts a terrible burden on Man because what he wants will determine what he will be. But even so this is a more hopeful concept than the alternative—that Man has reached the end of the line, that he is now the finished product and that he awaits only his inevitable expiration.

As an anthropologist Eiseley speaks with authority of Man's long history. As a scientist-poet (he objects to being called a mystic), he not only imagines the future, he experiences it. Thus, his report on a walk on a city street:

"Today I have been walking in the ruins of the city. The city still moves, it is true, the air drills ring against iron, and I am aware of laughter and of feet hurrying by at the noon hour. Nevertheless the city is in ruins. This is what the trained eye makes of it. It stands here in the morning sun while rust flakes the steel rails and the leaves of innumerable autumns blow mistily through the ribs of skyscrapers and over the fallen brickwork lies a tangle of morning glories. . . ."

The book gives us more, though, than the present thoughts and feelings of a remarkable man. It tells us how he came to be. Much of it is taken up by recollections of a strange childhood, of a boy from a troubled home who embarked on

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a secret life, as so many youngsters do, and was able to make it a part of his real life as he matured. The childhood memories are haunted and poignant and tell much about the man.

Today Eiseley sleeps with a night-light and is subject to insomnia. "There are moments," he says, "in my bed at midnight, or watching the play of moonlight on the ceiling, when this ghostliness of myself comes home to me with appalling force, when I lie tense, listening as if removed, far off, to the footfalls of my own heart, or seeing my own head on the pillow turning restlessly with the round staring eyes of a gigantic owl." And lying there, "more ghostly than a ghost," he wonders "Who? Who?"

Dark words, to be sure. Yet, for this reader, the ultimate message from *The Night Country* is hope. Like Thoreau proclaiming "There is more day to dawn. The sun is but a morning star," Eiseley states his own affirmation: ". . . One night's dying becomes tomorrow's birth. I, who do not sleep, can tell you this."
—*Charles B. Seib*
Author, *The Woods*

Songs America Voted By
Compiled by Irwin Silber
(Stackpole, $12.95)

In the Museum of History and Technology an orator stands on the rear platform of a train facing a line of oddly dressed men carrying torchlights. Across the scene flow unceasing songs, all plucked from the quadrennial political hooplas of the 19th century when Americans paraded and tried to vocalize "The Man Who . . ." into the White House. Smithsonian visitors who have been stirred by this exhibit of marvelous madness will enjoy Silber's chronicle.

Like the political diorama, the book raises two questions: How can anyone be sung into the White House? How can emotions, election after election, rise so high as to convince voters to turn the rascals out when casual thought would show that one side had as many as the other? But away with such trifling thoughts! Remember only that the gaslight era was flamboyant. Television had not educated people; the words of orators and the lyrics of songsmiths were believed, grabbed at like floating flower buds. Sentiments could flare.

Emotion and avarice certainly com-

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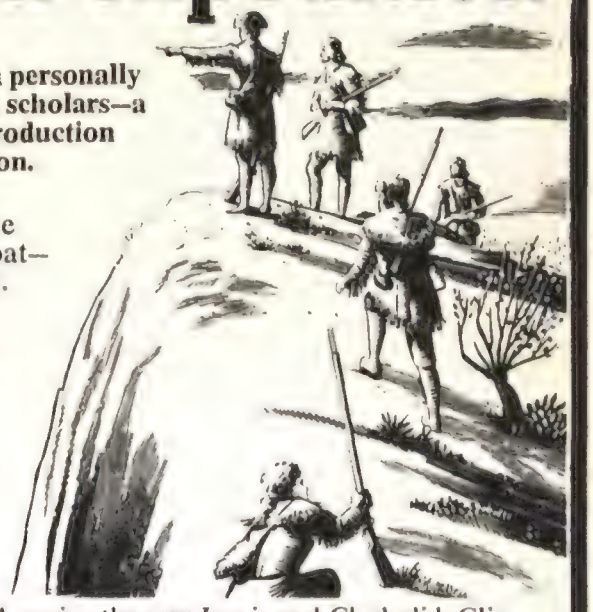

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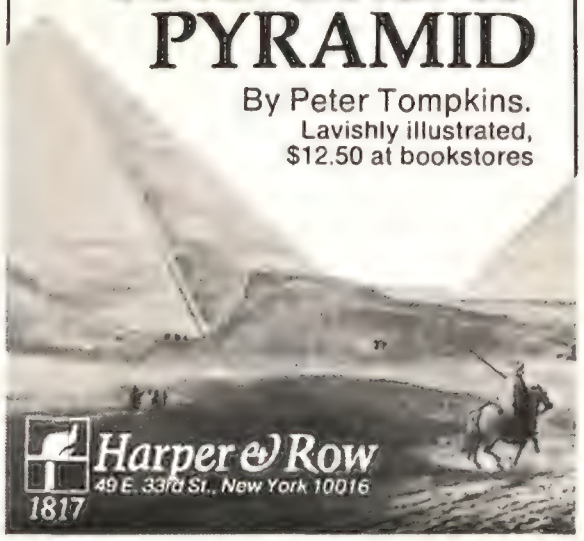

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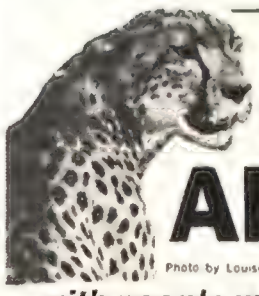

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bined to create the marching and singing. It all began around 1840 with formation of marching clubs, showerings of songbooks and sheet music and progressive improvements in torchlights. Silber says: "The famous 'Tippecanoe and Tyler Too' campaign marked the beginning of a new era in American politics."

The end of the flamboyance came about 1916. For some reason Harding didn't inspire songwriters. Later, Al Smith and Roosevelt, close to Tin Pan Alley, were sung about half-heartedly—though "The Sidewalks of New York" and "Happy Days are Here Again" are memorable. Compare these to the rambunctious old days when Democrats, ablaze at Republican misdoings, chanted "Blaine, Blaine, James G. Blaine/the Monumental Liar from the State of Maine." (We'd always heard it as "continental.") And the miracle bestowed upon Republicans, as a campaign issue, when a newspaper disclosed that Grover Cleveland was the father of a New York widow's illegitimate baby boy. Silber seems to have discovered a marching song based on this: "Ma! Ma! where's my Pa?" To which the widow replied: "Up in the White House, darling, Making the laws, working the cause, Up in the White House, dear." (Legend says the chant ended the line with "Gone to the White House, Ha, Ha, Ha.")

One must wonder about the effectiveness of the songs. The smear of Cleveland failed. But the songs, mostly atrocious in composition, and the parades evoke fascinating Americana, making the effectiveness secondary. I wish the author's fine scholarship had allowed a little more human interest and anecdotes, which are obtainable in abundance.

We do hear the songs fade into less than a sigh after 1916 although one, thanks to "Hello, Dolly," complimented the second Johnson in 1964: "Hello, Lyndon, Well, hello Lyndon, We'd be proud to have you back where you belong. . . ." Much superior to 1968: "Stand up! And let's take the band up! Who's lifting this land up? Yes, Nixon's the one to go with."

Silber doesn't despair. "Whatever the future holds . . . campaign songs will continue to be written; and they will continue to reveal something of the way in which the American people regard their politicians and the issues on which their campaigns are fought."

But the fact remains that now the songs are secondary. There is no foreseeable resurrection of a once beautifully lusty America limned in torchlight. Who marches today except in anger?

—*Scott Hart*

Washington journalist and historian

In the Shadow of Man
Jane van Lawick-Goodall
(Houghton Mifflin, $10)

Here is a wealth of fascinating information—perhaps a *Voyage of the Beagle* for primate behavior—in plain prose and pictures. Jane Goodall is the tyro British behaviorist who settled near Lake Tanganyika in 1960 to live with the chimpanzees. Toward the beginning of her decade there, under the aegis of Louis S.B. Leakey, the National Geographic Society commissioned a nature photographer, Hugo van Lawick, to illustrate her field study. Jane and Hugo married and then they compiled this collaborative effort.

The stars are: David Graybeard, Goliath, Flo, Olly, dominant Mike, the tragically ill-fated Mr. McGregor, Leakey (namesake, that is), Grosvenor and Gilka (for *National Geographic* people) and the other denizens of Gombe Stream Chimpanzee Reserve in Tanzania.

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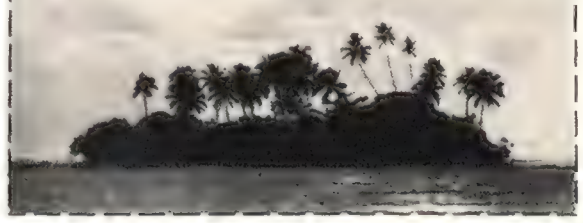

That the author chose to give the chimpanzees names instead of numbers heightens the undeniable humanness of these primates' habits, although many scientists will undoubtedly object to the anthropomorphisms.

However one wonders how much the author—and the feeding station she established—inadvertently affected the chimps' behavior. Certainly she could have avoided interfering on two occasions when she put fatally ailing chimps out of their misery. Though her attachment to these very human companions is understandable, it would have been more meaningful to let nature take its course and watch what happened.

But picking on Mrs. Van Lawick-Goodall for shortcomings is like debunking Edison for not inventing the laser. She is a pioneer, the first to make so dedicated a study of a natural chimpanzee community *in situ*. Her contribution is singular, and the book that recounts it is therefore highly valuable.

She confirms earlier chance observations that these primates eat meat—colobus monkeys, young baboons, bushbucks and bushpigs—sometimes actively hunting their prey. She was the first to observe chimps modifying sticks into tools to catch termites or to snare biting ants without being bitten themselves. She also observed them using leaves as compresses for wounds, as sponges for drinking rainwater and as toilet paper when diarrheic. Beyond all this, van Lawick's photographs and some drawings by David Bygott vividly record a gamut of facial expression and body language.

The author's most valuable accomplishments are annotating the stages of chimpanzee development, recording social patterns and hierarchical conventions in the wild and observing the sexual inclination's of female chimps. They copulate a dozen times a day with almost every male in sight. Lest this sound hedonistic, coupling takes barely 15 seconds. One interesting datum that anthropologists may ponder: Chimpanzees apparently ban identifiable incest between parent and young. Oedipal relationships between mother and sons were never observed; Electral ones, perforce, are often nigh impossible to determine among man or beast.

—Philip Kopper

Washington writer who has contributed to *National Geographic* books

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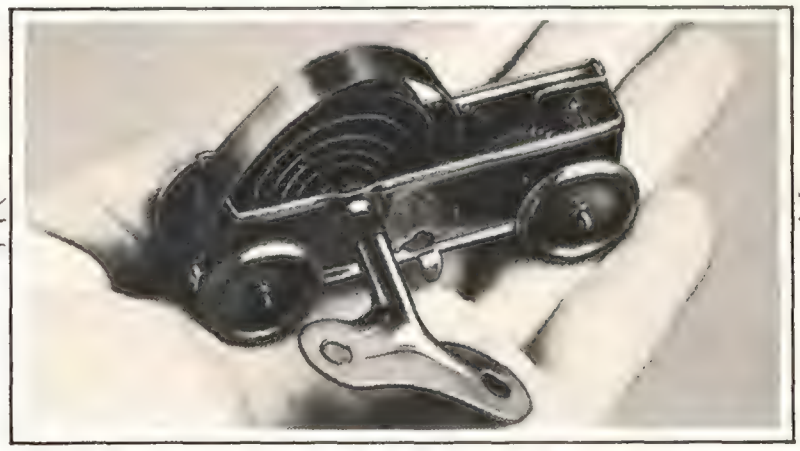

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Red Man's Land—White Man's Law
Wilcomb E. Washburn
(Scribner's, $7.95)

According to Thucydides in his Melian dialogue, the Athenians said to the people of Melos, "You know as well as we do that, when these matters are discussed by practical people, the standard of justice depends on the equality of power to compel and that in fact the strong do what they have the power to do and the weak accept what they have to accept."

And so speaks Wilcomb Washburn in the epilogue to his book. "The whites at first recognized and accepted the tribal and national character of the Indian collectivities with which they dealt. It could hardly have been otherwise. The very future of the colonies . . . depended upon a satisfactory accommodation to the power that could be marshaled by the Indian political units. With the decline of that power and the growth of the power of the intruders, the individual Indian became more and more subject to white codes of law and white regulation of his activities."

Wilcomb Washburn is director of American Studies at the Smithsonian Institution, an able historian who moves with understanding in the fields of archaeology and anthropology. Long interested in the American Indian, he exploded established historical doctrine with his study of Bacon's Rebellion in Colonial Virginia. With this book he has accomplished a similar task for the general reader.

Every institution of the white man's society set about swindling the Indian out of his land. One cringes at the activities of Christian clerics in accomplishing the grand scheme. Washburn writes at the beginning, ". . . by the time the American Indian came face to face with the doctrine of Christ it had hardened in a mold of bigotry, intolerance, militancy and greed which made it the mortal enemy of the native American."

He exposes the atypical timidity of Chief Justice John Marshall who ruled against the Indian out of fear of a fatal clash with the Presidency of Andrew Jackson, a devotee of rough-and-ready frontier justice.

Even so benevolent a friend of the Indian as Thomas Jefferson adopted the doctrine of Indian removal away from white expansion (which is still going on)

probably out of a practical realization that the federal government, with sole responsibility for Indian affairs, was incapable of protecting the Indians against either states or individuals.

The Senate failed to ratify treaties entered into in good faith by the Indians, and finally the Congress authorized the nearly fatal diminution of Indian land by passing the Dawes Act in 1887 which culminated in the eventual removal of nearly 90 million acres of land from Indian control.

There were not many heroes along the way. Father Las Casas was one when he spoke for the Indians' humanity at a special council of theologians in the mid-16th century. There were others. Justice Smith Thompson wrote a powerful dissent and was joined by Justice Joseph Story when the Supreme Court adopted Chief Justice Marshall's opinion against the Indians. And many a troubled American deplored what was happening to the native Americans. But it was not until the arrival of the New Deal, Harold Ickes, John Collier and the framers of the Wheeler-Howard Act that the country made the first firm attempt to reverse the course of history.

It is still too early to judge but this book will help any reader to judge for himself, and that was the task the author set for himself. The book is not a horror-filled litany of atrocities but rather an exposition in graphic prose of the tortured rationalizations which, when built one upon the other, encompass the history of Indian-white relations from the 16th century to date. If every American who read *Bury My Heart At Wounded Knee* reads this book, a large segment of the population will be truly well informed in Indian history.

—John Vance
Commissioner of Indian Claims

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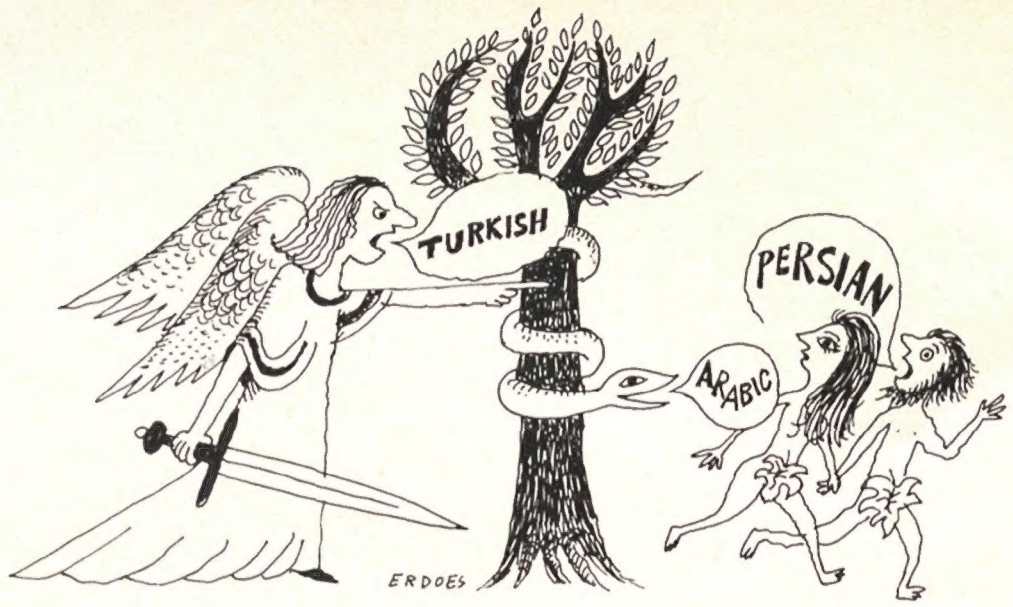
By Patrick Ryan

English language is a tongue for all reasons



On Biblical authority, until the families of the sons of Noah built the Tower of Babel to reach presumptuously up to the heavens, "the whole earth was of one language, and of one speech." In rebuke, the Lord "did there confound the language" and "scatter them abroad upon the face of all the earth" to such effect that there are said to be about 4,000 languages still spoken in the world today. But even though we presume to build rocket towers that send us to the moon, the Lord seems not to take offense, for we show a clear linguistic trend back towards a single language.

English—or perhaps more truly, Anglo-American—is progressively heading towards adoption as a universal language. As sovereign states proliferate, each with its own variety of externally incomprehensible tongues, and more nations develop to commercial involvement, so English is ever more widely used as a second language and the businessman's *lingua franca*. It is estimated that over 300 million people have English as their primary speech and another 600 million use it as a secondary language. Thus, nearly a billion people, about a quarter of the world's population, can already communicate in the lingo of Shakespeare. Which is fair progress considering that barely five million spoke English in his day.

Ever since it challenged Latin as the main medium of international learning in the 18th century, English has steadily gained acceptance as the language of science, sport, propaganda, diplomacy, hippiedom and now space aviation. A further scientific fillip to future growth has been provided by the International Confederation of Information Processing, which recently decided to use English in computer technology. In previous years the Confederation has arranged simultaneous translation into French and Russian but this year all proceedings were in English. So when computer finally converses consciously with computer, it's likely to be in metallic Anglo-American. This advance has not been unhindered. A French rearguard action still goes on.

There is competition from other tongues. Iranian legend holds that Arabic, Persian and Turkish were the three primitive languages of Paradise, the serpent seducing Eve in Arabic which is the most persuasive tongue; Adam and she conversing in Persian, the most poetic; and the Angel Gabriel giving them notice to quit in Turkish, the most menacing.

The Holy Roman emperor, Charles V, earlier said that he reserved German for addressing his horse, while speaking Italian to his women, French to men and Spanish to God. It might have paid him to try a bit of English on somebody, just for luck, because despite his polyglot conversations his reign was marked by an unregal lack of mistresses, lots of trouble with Luther, heavy afflictions of gout and final abdication of his imperial crown.

On the other hand a 92-year-old Scottish town councillor, concerned to increase the quantity of Gaelic literature on local public library shelves, pronounced to the library committee that "French is the best language for making love; English for business. But for approaching God Almighty you will be nearer to Him in Gaelic than in any other language." He might also have given his native tongue the palm over French for amorous pursuits since Gaelic thoughtfully has no word in its vocabulary to express a simple, direct "No!"

If the patriotic burgess should turn out to be right about the ancient dialect's specialty for heavenly communication, the Gaelic-lacking majority could be in for a bit of a shock on Judgment Day when they find themselves called to account, not by a patriarch after Michelangelo, but by a huge kilted Highlander preferring bagpipes to harps, haggis to ambrosia and usquebaugh to nectar.

Apart from its compulsory infliction on colonies on which the sun eventually set, the success of English can be attributed to its lack of genders and paucity of inflections. It is so devoid of difficult sounds that it can be comprehensibly spoken with a pipe in the mouth.

Besides this boon to smokers, its basic rudiments are of such simplicity that it can be learned for practical purposes more rapidly than any other language. During World War II when foreign pilots were trained in the United States, the Air Force found that a good working knowledge of English could be imparted in 60 hours of instruction. Which gives support to Mark Twain's conclusion that "a gifted person ought to learn English (barring spelling and pronunciation) in 30 hours, French in 30 days and German in 30 years."

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